

THE ORDOVICIAN TRILOBITE FAUNAS OF SOUTH SHROPSHIRE, II

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SYNOPSIS

The present paper is the second of four describing and figuring the trilobites of the Caradoc Series in south Shropshire. The families dealt with include the proparian Cheiruridae, Encrinuridae, Dalmanitidae and Pterygometopidae, and the gonatoparian Homalonotidae. These comprise nine genera and subgenera, containing seventeen species and subspecies, five of them new. The type-species of *Phacopidina* Bancroft is redescribed, the genus being removed from the subfamily Calmoniinae and assigned to the subfamily Acastinae as a subgenus of *Kloucekia* Delo.

SYSTEMATIC DESCRIPTIONS

Family CHEIRURIDAE Salter, 1864

Subfamily ACANTHOPARYPHINAE Whittington & Evitt, 1953

Genus *ACANTHOPARYPHA* Whittington & Evitt, 1953

TYPE SPECIES. *Acanthoparypha perforata* by original designation of Whittington & Evitt (1953 : 72).

Acanthoparypha stubblefieldi (Bancroft)

(Pl. 49, figs. 1, 3-6, 11)

1949. *Nieszkowskia stubblefieldi* Bancroft, p. 311, pl. 10, figs. 26, 27.1958. *Nieszkowskia stubblefieldi* Bancroft : Dean, pp. 201, 219.

The only figure of the cranium of the species published by Bancroft (1949, pl. 10, fig. 26) shows an incomplete and somewhat distorted internal mould which has apparently been slightly compressed laterally and sheared dextrally. It is necessary, therefore, to redescribe the species and to figure topotype material showing the true glabellar form. Bancroft's photograph does not give a true impression of the proportions of the glabella, and also exaggerates the angle at which the glabellar furrows are directed backwards.

DESCRIPTION. In plan the glabellar outline is subrectangular, with the frontal lobe only slightly convex forwards and the anterolateral margins and angles becoming respectively slightly convergent and rounded. The glabella is moderately convex both longitudinally and transversely, its length being estimated as slightly greater than the maximum breadth, measured across the second and third glabellar lobes. The anterior border is imperfectly preserved, but appears to be small and narrow (*sag.*). There are three pairs of glabellar lobes, those of the third pair being slightly the largest. The frontal glabellar lobe is short (*sag.*), less than one-fifth of the length of the glabella, and broad; frontally it is almost transversely straight, but the anterolateral margins are broadly rounded. The first glabellar furrows are deep, shallowing adaxially and curving inwards and backwards from the axial furrows for almost one-third the breadth of the glabella. The first glabellar lobes are subrectangular in plan and of uniform length (*exsag.*). The second glabellar furrows are deep, parallel to the first pair of furrows but turning slightly backwards at their proximal ends; in one specimen (Pl. 49, figs. 1, 4) the right-hand furrow of the second pair does not quite attain the axial furrow, but there is insufficient material to ascertain whether this is an exceptional case. The second glabellar lobes are of similar shape to those of the first pair, and of only slightly smaller size. The third glabellar furrows are deep, more or less parallel to the other pairs of furrows. They extend inwards from the axial furrows at an angle of about 65-70 degrees, but towards their proximal ends they turn back sharply through about 30 degrees and extend towards, though they do not reach, the occipital furrow. The proximal ends of the three pairs of glabellar furrows are almost longitudinally in line, forming a median body of uniform breadth.

The third glabellar lobes are larger than the other pairs and tend towards the so-called "cat's ear" outline (see Pl. 49, fig. 6), whilst the gently convex posterior margins give a sinuous appearance to the moderately deep occipital furrow. The occipital ring curves forwards slightly towards the axial furrows and is broader (*sag.*) than the posterior border; only the proximal parts of the latter are known and they are transversely straight. The fixigenae, librigenae and facial sutures have not been found preserved.

The hypostoma and thorax are unknown.

Only one specimen of the pygidium is available and, although incomplete, is estimated to have been slightly wider than long. The axis is roughly triangular with three axial rings and occupies one-third of the frontal breadth of the pygidium. First axial ring is narrow (*sag.*), curved sharply backwards distally where there are poorly-defined axial furrows. Beyond the axial furrows the pleurae of the first pair become suddenly and markedly wider (*exsag.*) and are produced posteriorly as a pair of large spines. The anterior edge of each pleura runs transversely straight from the axial furrow and then turns sharply backwards through a right angle to form the lateral margin of the pygidium. The posterior edges of the same pleurae almost coalesce with the second pleurae, being separated from them by only shallow interpleural furrows which extend posteriorly, parallel to the lateral margin until just beyond the tip of the axis; they then diverge backwards markedly and finally intersect the lateral margins so as to form long, stout pleural spines. The second pleurae are nearly continuous with the second axial ring, beyond the distal ends of which they are directed almost straight backwards as a pair of large, parallel spines, the bases of which meet proximally. Between their point of contact and the second axial ring is situated the third axial ring. This is not differentiated from its corresponding pleurae which converge sharply backwards and inwards, and meet to form a sub-triangular area with a central depression.

The surface of the glabella is covered with large tubercles, interspersed with smaller granules. Similar, though more closely crowded tubercles ornament the axial rings of the pygidium, whilst on the side-lobes they are much more dispersed. All the furrows on both cranium and pygidium are smooth.

HORIZON AND LOCALITY. *Acanthoparypha stubblefieldi* is known as yet from only one locality in south Shropshire, the old cartway section near the south-eastern corner of Smeathen Wood, Horderley, 250 yards west-south-west of Wood House. The horizon is in the Smeathen Wood Beds, Harnagian Stage, zone of *Reuscholithus reuschi*.

LECTOTYPE, here selected. BM. In. 42084a, b (Pl. 49, figs. 5, 11).

PARATYPE. BM. In. 52085 (Pl. 49, fig. 3).

FIGURED SPECIMENS. BM. In. 50498 (Pl. 49, fig. 1); BM. In. 50499 (Pl. 49, fig. 6).

DISCUSSION. The genus *Acanthoparypha*, although close to *Nieszkowskia* Schmidt, was separated by Whittington & Evitt so as to include only those *Nieszkowskia*-like forms which lack the glabellar spine such as is found in *N. cephaloceros* (Nieszkowski) the type species. They were unable to differentiate between the two genera on the basis of the pygidia.

Acanthoparypha perforata (Whittington & Evitt, 1953 : 73, pl. 13, figs. 2, 4-6; pls.

14-16; pl. 17, figs. 1-6), from the Edinburg Limestone of Virginia, is easily distinguished from *A. stubblefieldi* by its strongly convex glabella, the sides of which are more convergent anteriorly, and by the proportionately longer pygidium, with four long, subequal spines and only one fully-developed ring furrow, behind which is situated a deep, mesial pit.

The cephalon of *Acanthoparypha chiropyga* (Whittington & Evitt, 1953: 77, pl. 28, figs. 31-44; pl. 29; pl. 30, figs. 1-28, from the Lincolnshire Limestone of Virginia, possesses less coarsely-developed tuberculation than that of *A. perforata*. In this respect, and also in having better-defined glabellar furrows, it approaches *A. stubblefieldi* but can be separated from the latter by means of its more tapered glabellar outline and by its pygidium, only the first axial ring of which is known, but which has four pleural projections of almost equal size, and carries several large tubercles on its upper surface. Both these North American species are lower Middle Ordovician in age, and occur respectively at horizons which are generally contemporaneous with, and slightly earlier than, the Shropshire specimens.

Cheirurus variolaris was founded by Linnarsson (1869: 60, pl. 1, fig. 6) on an incomplete pygidium but later Schmidt (1881: 183, pl. 9, figs. 1-8) illustrated the species more fully and assigned it to *Nieszkowskia*, apparently correctly, as it has a glabellar spine. The trilobite which Schmidt (1881, pl. 11, figs. 25, 26) described as *Cheirurus* (*Nieszkowskia*) *variolaris* var. *mutica* lacks a glabellar spine and is apparently a true *Acanthoparypha*. The glabellar furrows and surface tuberculation resemble those of *A. stubblefieldi* but the glabella is more transversely convex and tapered frontally than the Shropshire species. *Acanthoparypha mutica* is from Stage C 1 of Gostilzy, and is therefore of generally similar age to *A. stubblefieldi*.

Subfamily CYRTOMETOPINAE Öpik, 1937

Genus **PSEUDOSPHAEREXOCHUS** Schmidt, 1881

TYPE SPECIES. *Sphaerexochus hemicranium* Kutorga, 1854 by subsequent designation of Reed (1896: 119).

***Pseudosphaerexochus* sp.**

(Pl. 49, figs. 2, 7, 8)

1958. *Pseudosphaerexochus* sp., Dean, pp. 213, 225.

Only one specimen is available, a large but somewhat distorted cephalon approximately 60 mm. wide. The glabella is large and inflated, with a basal breadth about one-third that of the cephalon; anteriorly it expands until, at about its mid-point, it attains a maximum breadth equal to half that of the cephalon. In front of the second glabellar lobes the glabella narrows, but details are obscured by crushing. There are three pairs of glabellar furrows. The first two pairs are moderately deep at their intersection with the axial furrows, but become shallower as they curve inwards and backwards, each furrow extending adaxially for about one-quarter of the breadth of the glabella. The first and second glabellar lobes are of similar form,

uniformly long (*exsag.*), and apparently parallel to each other. The third glabellar furrows are deep, directed only slightly backwards near the axial furrows; they then turn fairly sharply backwards and run towards, though they do not reach, the occipital furrow, at the same time becoming noticeably shallower. They delimit large, subangular basal glabellar lobes, each of which occupies almost one-third of the basal breadth of the glabella. The axial furrows are deep and narrow, though their narrowness may be exaggerated by crushing. The occipital furrow is narrow (*sag.*) and transversely straight, becoming deeper towards the axial furrows. The pleurooccipital furrow is deep near the axial furrows but shallows distally; towards the lateral margins it meets the lateral border furrows, demarcating a broad (*tr.*) lateral border which is continuous with the posterior border. The latter is narrow (*exsag.*) at the axial furrows but widens towards the genal angles which form broad, bluntly-pointed fixigenal spines. Only the left palpebral lobe is preserved intact, situated opposite the second glabellar lobes and about mid-way between the axial furrow and the lateral margin. It is small and short (*exsag.*), less than the length of the second glabellar lobes, with a poorly-defined palpebral furrow. The fixigenae are large, tumid and their surface is continuous with that of the librigenae. The two together are covered with conspicuous shallow pits extending as far as the lateral border furrow which separates them from the smooth lateral border, itself continuous with the distal portions of the smooth posterior border. As far as can be ascertained the surface of the glabella is smooth.

HORIZON AND LOCALITY. *Onnia* Beds, Onnian Stage, zone of *Onnia superba*, at the so-called "Cliff Section" in the north bank of the River Onny, 720 yards west-south-west of Wistanstow Church.

FIGURED SPECIMEN. BM. In. 50660.

DISCUSSION. *Pseudosphaerexochus* is figured here for the first time from Shropshire. In the Ordovician of England and Wales the genus is generally more characteristic of the Ashgill Series, though it is recorded from the Onnian and Pusgillian Stages of the Cross Fell Inlier (Dean, 1959a). Insufficient material is available for a detailed comparison, but the Onny specimen is larger than any of those from Cross Fell.

Family ENCRINURIDAE Angelin, 1854

Subfamily ENCRINURINAE Angelin, 1854

Genus *ENCINURUS* Emmrich, 1844

TYPE SPECIES. *Entomostracites punctatus* Wahlenberg, 1821 by original designation of Emmrich (1844: 16).

Encrinurus sp. (? nov.)

(Pl. 49, figs. 10, 12)

1958. *Encrinurus* sp., Dean, pp. 209, 223.

The single specimen available is a pygidium, strongly convex transversely and preserved as an internal mould. In outline it is almost triangular, the maximum

breadth, which is attained frontally, being approximately equal to the length. The axis occupies one-third of the frontal breadth and is delimited laterally by deep axial furrows which converge gently rearwards; it does not extend to the tip of the pygidium. There are at least sixteen or seventeen axial rings preserved, with room for a few additional rings as the axis at and near the terminal piece is slightly abraded. At least the first nine axial rings are entire, but owing to the state of preservation it is difficult to say whether the subsequent rings are obsolete mesially or whether this feature is due to abrasion. Traces of small, median tubercles are visible on the second, third, fifth, ninth, twelfth and thirteenth axial rings. Each side-lobe possesses seven well-defined ribs, with an eighth less well defined, separated from each other by conspicuous interpleural furrows which are only slightly narrower (*exsag.*) than the ribs themselves. The ribs of the first pair are transversely straight and horizontal as far as the fulcrum, beyond which they turn down and sharply back. Subsequent ribs turn backwards even more markedly, and the seventh and eighth pairs run almost straight back parallel to each other. As far as can be seen, all the ribs end in small, free points. Beyond the tip of the axis is a narrow, postaxial ridge which extends to the tip of the pygidium and is separated from the eighth pair of ribs by weak, shallow furrows.

HORIZON AND LOCALITY. The middle subdivision, the *Dalmanella unguis* Beds or Zone, of the Marshbrookian Stage, forming the upper half of the disused Marshwood Quarry, about half a mile south of Marshbrook Station.

FIGURED SPECIMEN. BM. In. 49312.

DISCUSSION. No other *Encrinurus* of comparable age or form has been described or figured from the Anglo-Welsh Caradoc Series, and the Shropshire species may be new. *Encrinurus trentonensis* Walcott (1879: 68; Wilson, 1947: 45, pl. 8, fig. 5) has a pygidium of generally similar type but carrying at least twenty-three axial rings and nine or ten pleural ribs. This species is from the Lower Trenton of Ontario and therefore probably rather earlier than the Shropshire specimen.

Subfamily CYBELINAE Holliday, 1942

Genus *ATRACTOPYGE* Hawle & Corda, 1847

TYPE SPECIES. *Calymene verrucosa* Dalman, 1827 by original designation of Hawle & Corda (1847: 90).

Atractopyge sp.

(Pl. 49, fig. 13)

1854. *Cybele verrucosa* Dalman: Salter & Aveline, p. 67.

1958. *Atractopyge* sp., Dean, p. 211.

Only one specimen has so far been collected from south Shropshire, a damaged pygidium with axis almost complete, and retaining part of the side-lobes. The maximum length, excluding the articulating half-ring, is 15 mm. The length of the axis is three times the breadth, and its sides are parallel for about two-thirds of the length but then converge to meet at the pointed axial tip. There are at least twelve

axial rings, though the posterior portion of the axis is too badly damaged for more to be distinguished. The first four axial rings pass laterally without interruption into the ribs of the side-lobes, axial furrows being present merely as ill-defined, shallow, longitudinal depressions; only to the rear of the fourth axial ring is the axis defined laterally by deep axial furrows which curve gently back to the pointed tip. The first two, and perhaps three, axial rings are entire across the median line, but all subsequent rings are obsolete medially for about one-third of their breadth (*tr.*), so that they appear to be defined by two series of transverse notches which run adaxially from just inside the axial furrows and are separated from each other by a median band which extends, apparently, to the tip of the axis. This band is mostly smooth, but the fifth to seventh, and perhaps also the fourth, axial rings bear traces of paired median tubercles. The ring furrows beyond the sixth become gradually more reduced. The first four axial rings are produced laterally to form the ribs of the side-lobes and extend transversely for a short distance from the axis; they then curve sharply backwards and at the same time converge slightly so that the fourth pair of ribs embraces the sides of the axis and terminates in a pair of free points which almost meet just beyond its tip. The remaining ribs, from first to third, run parallel to the fourth pair and terminate in a series of free points which are not in line but are stepped adaxially rearwards from first to fourth. Each rib of the fourth pair carries a poorly-defined tubercle opposite the seventh, tenth and twelfth ring furrows, and similar tubercles are visible on the other ribs, though the preservation is too poor to ascertain their exact distribution.

HORIZON AND LOCALITY. The disused quarry by the east side of the road, almost opposite Church Farm, Acton Scott, in the Acton Scott Beds (s.s.), representing part of the middle third of the Actonian Stage.

FIGURED SPECIMEN. BM. In. 49319.

DISCUSSION. The name "*Cybele verrucosa*" has been applied indiscriminately for many years to specimens of *Atractopyge* from a large number of horizons and localities in Britain, and it seems probable that several different species will prove to be involved when they are better known. The true *Atractopyge verrucosa* was first described by Dalman (1827) from the Red *Tretaspis* Shales of Billingen, Västergötland, but the original illustrations were too poor for detailed comparison. More recently Henningsmoen (*in* Moore, 1959, fig. 349, *1a*, *b*) has refigured the species from type material; his illustration of the pygidium shows there are about eleven axial rings behind the first four entire axial ring furrows, and that the tips of the pleural ribs end almost in line with each other. This last feature marks a conspicuous difference from the Shropshire specimen, which probably also has fewer axial rings.

The species described by M'Coy (*in* Sedgwick & M'Coy, 1851: 156, pl. 16, figs. 1-5) as *Zethus attractopyge* has often been regarded as a synonym of *Atractopyge verrucosa*, and is certainly congeneric with the latter. *Atractopyge attractopyge* was founded on a number of syntypes in the Sedgwick Museum numbered A. 41875, A. 41903 and A. 41904a, *b*, deriving respectively from "Alt yr Anker, Meifod" (now Gallt-yr-Ankr), "the schists of Ravenstone Dale" (presumably the Cautley district), and "the slate of Coniston". Of these the pygidium from near Meifod (M'Coy, fig. 4) is here chosen as lectotype, the other two being either incom-

plete or distorted. The hill of Gallt-yr-Ancr, near Meifod, Montgomeryshire, is made up largely of Caradoc strata belonging to the Soudleyan and Longvillian Stages. M'Coy's species is in need of redescription from topotype material and its exact type locality is, unfortunately, not known, but King (1928 : 698) has recorded "*Cybele verrucosa*" as occurring commonly at one locality on Gallt-yr-Ancr, as well as several others in the district, in company with *Pterygometopus* (now *Estoniops*) *jukesi* (Salter), a species which, so far as is known, is restricted to the Upper Longvillian Substage and is regarded here as a subjective synonym of *Estoniops alifrons* (M'Coy, 1851).

Two pygidia assigned to *Atractopyge* have been figured from the Derfel Limestone of North Wales by Whittington (*in* Whittington & Williams, 1955, pl. 40, figs. 109, 110). One of these (fig. 109) is broadly comparable with the Shropshire specimen, though the preservation is too poor for detailed comparison, but the other (fig. 110) appears to be a typical *Paracybeloides* of the *girvanensis* (Reed) species-group. As has been noted elsewhere (Dean, 1958 : 212), the association of *Atractopyge*, *Illaenus*, *Platylichas* and *Nicolella* in the Derfel Limestone is matched at a much later date in south Shropshire by part of the fauna of the Actonian Stage.

In west Shropshire Whittard (1960 : 126, pl. 17, figs. 12-16) has recorded the Scottish species *Atractopyge michelli* (Reed) from the Llandeilo Series; the Acton Scott form can readily be separated from this species by means of its narrower, proportionately longer pygidial axis. *Atractopyge killochanensis* (Tripp, 1954 : 678, pl. 4, figs. 1-5), though broadly similar to the east Shropshire species may be distinguished by the proportionately longer axis behind the first four axial rings, and by the free points of the pleural ribs which are markedly convergent backwards.

Family DALMANITIDAE Reed, 1905

Subfamily ACASTINAE Delo, 1935

Genus *KLOUCEKIA* Delo, 1935

? 1956. *Dreyfussina* Choubert *et al.*, p. 394.

TYPE SPECIES. *Phacops phillipsi* Barrande, 1846 by original designation of Delo (1935 : 408).

Subgenus *Phacopidina* Bancroft, 1949

Phacopidina was first proposed by Bancroft (1949 : 310) as a genus of the family Phacopidae. Both Pillet (1954) and Hupé (1955 : 261) placed it in the subfamily Acastinae, using the latter as a subdivision of the Phacopidae, but since then Struve (*in* Moore, 1959 : 0.486) has preferred to assign the genus to the subfamily Calmoniinae, within the family Calmoniidae. Struve qualified this transfer by claiming that *Phacopidina* is closer to what he called "the Calmoniinae trend" on account of the direction of the second glabellar furrows, the pairs of glabellar lobes of equal size, and the shape of the genal spines. He pointed out that Bancroft's illustration of the type-species was indifferent, but his own diagram of a, presumably, mature individual of *Phacopidina harnagensis* Bancroft (Struve *in* Moore, 1959, fig. 385, 4a, b)

is in turn somewhat misleading. The first glabellar furrows are too deeply impressed, the second furrows diverge forwards too strongly and are shown to reach the axial furrows, the genal spines are too short, and the facial suture is omitted. As will be described later, features approaching some of these are to be found in immature specimens of *Kloucekia* (*P.*) *harnagensis*, but in a typical adult individual the first and second glabellar lobes are fused distally, the second furrows being slightly curved, convex forwards, and not reaching the axial furrows. These characters are considered here to more in keeping with those of the subfamily Acastinae.

The Barrande Collection of Bohemian trilobites at the British Museum (Natural History) contains several specimens of *Kloucekia phillipsi* (Barrande), and examination of these has shown that the cephalae of *Kloucekia* and *Phacopidina* are indistinguishable. One specimen, In. 42327, has had the genal angle developed to show the existence there of an extremely small fixigenal spine, smaller even than that of *Phacopidina*, but situated in an analogous position. The only difference between *Kloucekia* and *Phacopidina* appears to lie in the latter's possession of a mucronate pygidium, and it has been found convenient to separate the two subgenerically on this basis.

Recently the name *Dreyfussina* was proposed (Choubert *et al.*, 1956 : 394) as a subgenus of *Phacopidina*, though no adequate diagnosis or description was given. The type-species of *Dreyfussina* was originally described by Dreyfuss (1948 : 56, pl. 5, figs. 1-5, pl. 9, figs. 6, 7, 9) as *Dalmania exophthalma* from the Caradoc of the Montagne Noire in southern France. His photograph of the cephalon is indistinct and difficult to match with his line drawings in the same paper, which show the second glabellar furrows diverging forwards to cut the axial furrows. In all other respects *Dreyfussina* resembles a typical *Kloucekia* and the two may well be synonymous.

TYPE SPECIES. *Phacopidina harnagensis* by original designation of Bancroft (1949 : 310).

Kloucekia (*Phacopidina*) *harnagensis* (Bancroft)

(Pl. 49, figs. 9, 14 ; Pl. 50, figs. 1-5)

1949. *Phacopidina harnagensis* Bancroft, p. 310, pl. 10, figs. 24, 25.

1958. *Phacopidina harnagensis* Bancroft : Dean, p. 201.

1959. *Phacopidina harnagensis* Bancroft : Struve in Moore, p. O.486, fig. 385, 4a, b.

DESCRIPTION. The cephalic outline is sub-semicircular, bluntly pointed frontally ; the maximum breadth is almost twice the median length and is measured approximately at the line of the pleurooccipital furrow. The glabella is pentagonal in outline, expanding anteriorly to attain its maximum breadth across the frontal glabellar lobe, the apex of which is bluntly pointed ; the median length is slightly more than the breadth. The axial furrows are almost straight, diverging forwards at about 30 degrees ; they are moderately deep posteriorly, becoming shallowest anteriorly where poorly-defined hypostomal pits are sited just forwards of the first glabellar furrows. There are three pairs of glabellar lobes and furrows. The first glabellar lobes are roughly triangular in shape, slightly larger than the other glabellar lobes. The first glabellar furrows are almost obsolete ; distally they cut the axial furrows, whence

they run adaxially and sharply backwards until they end longitudinally in line with the other glabellar furrows, leaving a smooth, median band. The second glabellar lobes are smaller, becoming shorter (*exsag.*) distally. They are bounded anteriorly by the second glabellar furrows which are faintly impressed, slightly curved, convex side forwards, set almost at right angles to the sagittal line, and which do not attain the axial furrows. The third glabellar furrows are deep, with apodemes, directed adaxially and slightly rearwards from the axial furrows, each extending across about one-third of the breadth of the glabella. The third glabellar lobes are subtriangular in outline, and in the internal mould they appear to constrict adaxially owing to the presence of apodemes in the occipital and third glabellar furrows. The frontal glabellar lobe is transversely lozenge-like in outline, with median length about half the breadth; the straight, anterolateral margins converge frontally at 135 degrees, meeting at the bluntly-pointed apex. The anterior border of the cephalon is a thin, raised rim which becomes obsolete laterally, just beyond the line of the axial furrows, and is separated from the glabella by a narrow (*sag.*), moderately deep furrow containing the anterior branches of the facial suture. The lateral border furrows are represented by shallow depressions running parallel to the lateral margins and extending from the axial furrows almost to the outer ends of the pleuroccipital furrow. The distal parts of the occipital furrow are transversely straight and deep with apodemes, but the median third is much shallower and set forwards. The occipital ring is transversely convex, longest medially, becoming shorter distally where it curves forwards slightly to form a pair of small occipital lobes. The pleuroccipital furrow is set slightly to the rear of the distal ends of the occipital furrow; it is deep and broad (*exsag.*) adaxially, and extends distally in an almost straight line, becoming shallower towards, but not reaching, the lateral margins. The posterior border is narrow (*exsag.*) immediately outside the axial furrows, but becomes markedly wider (*exsag.*) abaxially where the blunt genal angles are produced rearwards to form a pair of small, thin genal spines. The latter are situated a short distance adaxially from the lateral margins and are seldom preserved intact. The eyes are crescentic in plan, and slightly divergent backwards. Their anterior ends are sited just outside the axial furrows, opposite the anterior halves of the first glabellar lobes, and they extend back and slightly outwards until they are level with the posterior halves of the second glabellar lobes. The ocular surfaces are schizochroal and that of the lectotype, though damaged, has a total of about 115 facets on the right eye, arranged in twenty-three vertical rows. The palpebral lobes are broad (*tr.*) and horizontal, delimited adaxially by broad (*tr.*), shallow palpebral furrows, and poorly defined frontally where they extend beyond the eye as far as the axial furrows. The fixigenae decline gently from the palpebral furrows to the axial furrows, but more steeply abaxially from behind the eyes to the lateral margin. The anterior branches of the facial suture are slightly convergent forwards, where they cut the axial furrows just in front of the hypostomal pits; they then follow the outline of the frontal glabellar lobe and meet frontally at its apex. The posterior branches curve gently forwards from the rear ends of the eyes and then slightly rearwards, cutting the lateral margins approximately in line with the third glabellar furrows.

A few immature cranidia have been found, one of which is illustrated (Pl. 50,

fig. 4). They differ from those of typical adult individuals in the following respects : the glabella is slightly narrower across the third glabellar lobes, so that the axial furrows appear more divergent forwards ; the glabellar lobes decrease noticeably in size from front to rear ; the second glabellar furrows are deep and transversely straight, intersecting the axial furrows ; and the first glabellar furrows are better defined than in the adult form.

The hypostoma is unknown.

The thorax consists of eleven segments and is divided into three longitudinal lobes of approximately equal breadth by well-developed axial furrows. Each axial ring is moderately convex transversely and is curved forwards both medially and distally. The pleurae extend abaxially and horizontally for about half their length (*tr.*) as far as the fulcra, where they turn downwards through almost a right angle, at the same time curving first rearwards and then forwards slightly towards the tips, which are truncated, convergent forwards. The anterolateral part of each pleural tip is bluntly rounded, but the posterolateral part is almost a right angle, produced distally to form a small, projecting process (see Pl. 50, fig. 1) which probably functioned as a " stop " during enrolment. The proximal half of the upper surface of each pleura is horizontal, but beyond the fulcrum the distal half forms a surface which intersects the proximal half obliquely so as to form a slight ridge extending from the anterior border near the fulcrum to the posterior border just inside the pleural tip. Each pleura carries a pleural furrow which commences at the intersection of the axial furrow and the anterior border of the pleura ; the furrow then curves gently and abaxially rearwards, and finally forwards in the direction of, though without reaching, the pleural tip. The proximal half of the furrow is markedly deep, but beyond the oblique ridge near the fulcrum, as described above, it becomes markedly shallower for the remainder of its length (*tr.*).

The pygidium is broadly subparabolic in outline, its anterior margin only moderately convex, and length, excluding the terminal spine, roughly half the maximum breadth. The axis is delimited laterally by pronounced axial furrows, does not reach the posterior margin, and there are seven axial rings, of which the first four are the most clearly defined. Each side-lobe has a pronounced facet situated anterolaterally, and five ribs separated from each other by well-impressed pleural furrows and carrying fainter rib furrows. All these furrows die out laterally, leaving a smooth border. The margins of the pygidium are entire and pass posteriorly into a conspicuous, smooth spine, in length about one-third of the pygidium and rising from the axis at an angle of about 30 degrees. Behind the tip of the axis is a small postaxial ridge which merges into the base of the terminal spine.

In general the dorsal surface of the entire exoskeleton appears to be smooth but occasional well-preserved specimens show that the test, with the exception of the furrows and terminal spine, may be covered with fine, closely-set granules.

HORIZON AND LOCALITIES. The type-specimens are from the section in the disused cartway by the south-eastern corner of Smeathen Wood, 250 yards west-south-west of Wood House, five-sixths of a mile south of Horderley Station. The horizon is in the lowest part of the Harnagian Stage, the zone of *Reuscholithus reuschi*. At this locality the species is fairly abundant and is associated with *R. reuschi* Bancroft,

Smeathenia smeathenensis (Bancroft) and *Smeathenella harnagensis* Bancroft. *Kloucekia* (*Phacopidina*) *harnagensis* occurs also, but in less abundance, at the field exposure 550 yards north-west of Woolston House, Woolston. No other localities are yet known.

LECTOTYPE, here selected. BM. In. 42089 (Pl. 50, figs. 1, 5).

PARATYPE. BM. In. 42088 (Pl. 50, fig. 3).

FIGURED SPECIMENS. BM. In. 40131 (Pl. 49, figs. 9, 14) ; BM. In. 50576 (Pl. 50, fig. 2) ; BM. In. 52211 (Pl. 50, fig. 4).

DISCUSSION. It has been found more convenient to group this section with that of *Kloucekia* (*Phacopidina*) *apiculata* (M'Coy) later in this paper (see p. 326).

Kloucekia (*Phacopidina*) *apiculata* (M'Coy)

(Pl. 50, figs. 6-10, 12)

1847. *Phacops apiculatus* MS. Sedgwick, p. 149. *Nomen nudum*.

1851. *Portlockia* ? *apiculata* M'Coy ex Salter MS., in Sedgwick & M'Coy, p. 162, pl. 16, figs. 18, 19 only.

1852. *Phacops* (*Phacops*) *apiculatus* Salter, p. iii.

1853. *Phacops* (*Acaste*) *apiculatus* Salter : Salter, p. 9.

1859. *Phacops apiculatus* Salter : Murchison, p. 75, fig. 3.

1864. *Phacops* (*Acaste*) *apiculatus* Salter : Salter, p. 28, pl. 1, figs. 36-38.

1867. *Phacops apiculatus* Salter : Murchison, p. 69, fig. 3.

1924. *Dalmanitina apiculata* (Salter) : McLearn, p. 166.

1939. "*Acaste*" *apiculata* (Salter) : Stubblefield, p. 56.

1945. *Dalmanitina apiculata* (Salter) : Bancroft, p. 195.

1947. *Scotiella apiculata* (Salter) : Harper, p. 169. pl. 6, figs. 6, 9.

1949. *Phacopidina apiculata* (Salter) : Bancroft, p. 310.

1958. *Phacopidina apiculata* (Salter) : Dean, pp. 206-207, 221-222.

1959. *Phacopidina apiculata* (M'Coy) : Dean, p. 146.

1959a. *Phacopidina apiculata* (M'Coy) : Dean, pp. 212, 214, 220.

DESCRIPTION. The cephalic outline is almost semicircular, its length about two-thirds of the maximum breadth which is measured just in front of the pleuroccipital furrow. The glabella is pentagonal in plan, expanded anteriorly and bluntly pointed in front ; its length is about equal to, or slightly greater than, its maximum breadth. There are three pairs of glabellar furrows and glabellar lobes. The first glabellar furrows are shallow, in some cases almost obsolete, particularly adaxially, and run almost straight inwards and rearwards from the axial furrows. The first glabellar lobes are subtriangular in form, whilst the second glabellar lobes are subrectangular. The two pairs of lobes become fused distally, but proximally they are separated by shallow, slightly curved second glabellar furrows, convex forwards and set at right angles to the median line of the glabella. The third glabellar furrows, deep and with apodemes, are straight, directed inwards and rearwards from the axial furrows for about one-third of the glabellar breadth. The third glabellar lobes are subtriangular in outline, not unlike the slightly larger first glabellar lobes. All the glabellar lobes and the frontal glabellar lobe are moderately convex in line with one another. The axial furrows are almost straight, becoming slightly convex laterally opposite the first glabellar lobes ; they are shallow medially, deepening to front and rear, and

inconspicuous hypostomal pits occur opposite the distal ends of the first glabellar furrows. The glabella is bounded frontally by a narrow (*sag.*) groove, representing the preglabellar furrow and field, and immediately in front of this rises the anterior border, uniformly narrow (*sag.*) and parallel to the margin of the frontal glabellar lobe. The occipital furrow is curved forwards and shallow medially, deepening laterally where a pair of apodemes is situated just inwards from the axial furrows. The occipital ring is transversely convex, longest medially but shortening (*exsag.*) distally where it curves forwards slightly so as to form a pair of occipital lobes. The pleuroccipital furrow is deep and moderately wide (*exsag.*) near the axial furrows but becomes shallower distally and finally dies out before reaching the lateral margins. The posterior border is narrow by the axial furrows but widens (*exsag.*) distally and terminates posterolaterally in a pair of almost right-angled genal angles which are produced into a pair of small, sharp fixigenal spines directed backwards and slightly outwards (see Pl. 50, fig. 6). The largest-known fixigenal spine, about 2.5 mm. long, belongs to a cephalon 11 mm. in median length.

The eyes are crescentic in plan with prominent palpebral lobes which commence at the axial furrows, immediately behind the distal ends of the first glabellar furrows, and run rearwards, curving first abaxially and then adaxially until they terminate opposite the frontal half of the third glabellar lobes and a short distance outside the axial furrows. Moderately-deep palpebral furrows run parallel to the margins of the palpebral lobes and die out as they skirt the rear ends of the eyes. The eye surfaces are schizochroal and, in the case of a cephalon 8 mm. long, each contains at least thirty-two vertical rows of up to eight facets. From the palpebral lobes the proximal surface of the fixigenae slopes steeply down to the axial furrows; the distal surface is rather less steeply declined to the poorly-defined marginal furrows, situated just inwards from the lateral margins. The anterior branches of the facial suture are at first virtually coincident with the axial furrows, then skirt the frontal glabellar lobe and finally coalesce at the apex of the latter. The posterior branches of the suture are sigmoidal, curving gently forwards from the ends of the eyes and then backwards to cut the lateral margins opposite the mid-point of the third glabellar lobes.

The hypostoma is unknown.

No syntype thorax was available to Harper (1947) in his redescription, and only one, moderately well-preserved Shropshire specimen has been found (Pl. 50, fig. 12). This contains eleven thoracic segments and appears to agree in all essentials with the thorax of *Kloucekia* (*Phacopidina*) *harnagensis* already described (see p. 323), although full details of the pleural points cannot be distinguished. The pygidium, excluding terminal spine, is subparabolic in outline, with frontal margin moderately convex forwards. Frontally the axis occupies between one-quarter and one-third of the maximum breadth and it is bounded laterally by deep axial furrows which converge gently rearwards. A maximum of eight axial rings is present but beyond the fifth ring these are often difficult to distinguish, particularly in internal moulds. Each side-lobe is convex with an anterolateral facet, and there are five deep pleural furrows. The ribs so formed carry faintly-impressed rib furrows and these, together with the pleural furrows, do not reach the lateral margin, extending only as far as the smooth border which also defines the extent of the doublure. At the tip of the

pygidium the border is produced to form a thorn-like terminal spine, directed upwards and backwards (see Pl. 50, fig. 8) and equal to almost one-third of the length of the pygidium proper. The axis extends only to the smooth border but is connected to the base of the terminal spine by a low postaxial ridge.

The surface of the exoskeleton is apparently smooth in most individuals, but occasional specimens show trances of fine granulation, at least on the surface of the cephalon.

HORIZON AND LOCALITIES. In south Shropshire *Kloucekia (Phacopidina) apiculata* is first encountered in the lowest subdivision of the Lower Longvillian Substage, the zone of *Dalmanella horderleyensis*. It then ranges upwards through the remainder of the Lower Longvillian, though not in large numbers. In the succeeding Upper Longvillian Substage the species is more abundant, although, like the remainder of the fauna, it is generally most common in calcareous bands within the large thickness of flags and sandy shales constituting the Alternata Limestone and Lower Cheney Longville Flags. In an earlier paper (Dean, 1958 : 223) *K. (P.) apiculata* was recorded from the Marshbrookian Stage, but the evidence for this was fragmentary and unsatisfactory, and it is still not known for certain whether the species occurs outside the limits of the Longvillian Stage of which it is so characteristic.

The species is to be found at numerous points along the Longvillian outcrop throughout the Caradoc District but the following may particularly be noted. *Lower Longvillian Substage*: Long Lane Quarry, two-thirds of a mile south-west of Cheney Longville; the large road-side quarry 280 yards south-east of Glenburrell Farm, Horderley; various exposures near the top of Rookery Wood, just south of the River Onny three-quarters of a mile south-east of Horderley; the quarry by the east side of the road 590 yards east-north-east of Cwm Head Farm, one and a half miles north-east of Horderley. *Upper Longvillian Substage*: various exposures along Longville Lane, from 400 to 440 yards north-west of the "Earthwork" at Cheney Longville; the old quarry below the north side of the track at the north-eastern corner of Burrells Coppice, one mile south-east of Horderley Station; various exposures by the north side of the Bishops Castle road to the east of New House, just east of Horderley; the stream-bed by the west side of the Horderley-Marshbrook road, 560 yards north-east of Crosspipes; Soudley Quarry, near Soudley Pool, between Hope Bowdler and Ticklerton.

LECTOTYPE, selected by Harper (1947 : 170). Sedgwick Mus. A. 10962, a cephalon originally figured by M'Coy (*in* Sedgwick & M'Coy, 1851, pl. 16, fig. 18) from "Caradoc Beds" near Glyn Ceiriog, Montgomeryshire, and probably of Longvillian age.

FIGURED SPECIMENS. BM. In. 32253 (Pl. 50, fig. 6); BM. In. 51259 (Pl. 49, figs. 7, 8); BM. In. 51260 (Pl. 50, fig. 9); BM. In. 50558 (Pl. 49, fig. 12).

DISCUSSION. *Kloucekia (Phacopidina) apiculata* is one of a number of fossil species, including also *Brongniartella bisulcata* and *B. rudis* (see p. 345), the authorship of which has usually been attributed to Salter. Salter had, in fact, prepared descriptions of some new species which were to be published as an appendix to Sedgwick & M'Coy's great work on the British Palaeozoic rocks and fossils. Publication of the appendix was delayed until July, 1852, and in the meantime M'Coy had published, in May, 1851, his own longer and more detailed descriptions, using Salter's manuscript

specific names but frequently changing the genera to which they were assigned. There is no question of M'Coy's having used Salter's descriptions, and Sedgwick (*in* Sedgwick & M'Coy, 1851 : xiii-xiv) stated that "With the exception of the Appendix to the Second Fasciculus (which is from the pen of my friend and former fellow-labourer Mr. Salter) all the descriptions of the following works are due, exclusively, to Professor M'Coy . . . ". M'Coy must therefore be considered the author of the species in question. Salter's descriptions in the Appendix (1852) refer to the plates published in the preceding year and M'Coy's *Portlockia* ? *apiculata* was described by Salter as *Phacops* (*Phacops*) *apiculatus* sp. nov. The lectotype chosen by Harper is one of the specimens figured by M'Coy in 1851. The specific name as used for the first time by Sedgwick (1847 : 149) was invalid.

Although no other forms of *Kloucekia* have been found in Shropshire between *K. (P.) harnagensis* in the lower Harnagian Stage and *K. (P.) apiculata* in the Lower Longvillian Substage, nevertheless the two species appear to be closely related. They may be distinguished by the fact that *K. (P.) harnagensis* has a slightly shorter pygidium, and that the eyes of *K. (P.) apiculata* are larger and less divergent backwards. A feature common to immature individuals of both species is the lateral extension of the second glabellar furrows, which are transversely straight, to cut the axial furrows. The only other described British species of *Kloucekia*, originally *Scotiella major* (Harper, 1947 : 171, pl. 6, fig. 11), was separated by means of its short cephalon, the length of which is equal to less than half the breadth. *K. (P.) major* was described from the Lower Longvillian Substage of Caernarvonshire.

Both *K. (P.) apiculata* and *K. (P.) major* were assigned to the more typically Silurian genus *Scotiella* by Harper (1947 : 169), but recently Struve (*in* Moore, 1959 : 0.486) has maintained *Phacopidina* as a separate genus. The type species of *Scotiella* (Delo, 1935 : 409 ; 1940 : 33) is *S. logani* (Hall) from the Silurian of Nova Scotia, and differs from typical species of *Kloucekia* in the following respects : the first glabellar furrows are obsolete ; the second glabellar furrows of adult individuals cut the axial furrows ; the anterior branches of the facial suture converge frontally from the eyes to the frontal lobe ; fixigenal spines are totally absent and the genal angles are rounded.

The trilobite described by Barrande (1852 : 556, pl. 26, figs. 44, 45 ; pl. 27, figs. 12-14) as *Dalmanites solitaria*, from Stage D of Bohemia, has been placed doubtfully in *Phacopidina* by Struve (*in* Moore, 1959 : 0.486, fig. 385). Struve's illustration shows the second glabellar furrows definitely cutting the axial furrows, though this is not apparent from Barrande's original figures. *D. solitaria* possesses a mucronate pygidium, and examination of a topotype specimen, BM. In. 42336, from Gross Kuchel, Czechoslovakia, suggests there is little doubt that the species is a typical *Kloucekia* (*Phacopidina*) not very different from the Anglo-Welsh species.

Phacops cf. *apiculatus* was recorded by King (*in* Wedd *et al.*, 1929 : 61) from the Ashgill Series of the Oswestry district, but the specimen in question, GSM. WK. 218, is a small pygidium of *Phillipsinella parabola* (Barrande), and it is extremely doubtful whether a true *Kloucekia* (*Phacopidina*) *apiculata* has been found higher than the Caradoc Series.

Family PTERYGOMETOPIDAE Reed, 1905

Subfamily PTERYGOMETOPINAE Reed, 1905

Genus *CALYPTAULAX* Cooper, 1930

The genus *Homalops* was introduced in 1884 by Remelé (p. 200), though only briefly diagnosed, and was figured by him in the following year (1885 : 25, fig. 3). Remelé's species *Homalops altumi* was redescribed later by Wiman (1907 : 130, 131, pl. 8, figs. 7-10) who considered *Homalops* to be a subgenus of *Phacops*. In the meantime Reed (1905 : 226-228) had included *Homalops* in his subfamily Pterygomtopinae but had considered it to be too indifferently defined to be retained, and quoted as reference only Remelé's 1884 paper. Later Kozłowski (1923 : 29) rejected the genus on the grounds that it had never been adequately described or figured, and was apparently unaware of either Remelé's 1885 work or that of Wiman. In a later classification of the Phacopidae Reed (1927 : 352, 353) omitted all mention of *Homalops*. Wiman's more than adequate illustrations show that *Homalops* Remelé is identical with the later described *Calyptaulax* Cooper, 1930. It is clear that the name cannot, therefore, be rejected on the grounds of insufficient diagnosis, and certain Swedish material has, in fact, been referred to *Homalops* by Jaanusson (1953 : 102), but *Homalops* Remelé, 1884 is a junior homonym of both *Homalops* Burmeister, 1840 and *Homalops* Motschoulsky, 1850, and is now regarded as a subjective synonym of *Calyptaulax*.

TYPE SPECIES. *Calyptaulax glabella* by original designation of Cooper (1930 : 387).

Calyptaulax actonensis sp. nov.

(Pl. 50, figs. 11, 13, 14 ; Pl. 51, figs. 1, 2)

1958. *Calyptaulax* sp. Dean, pp. 211, 212, 224.

DIAGNOSIS. Cranidium typical of the genus. Pygidium broader than long, with six interpleural furrows, up to twelve axial ring furrows, and terminating in a blunt, upturned point.

DESCRIPTION. The glabella is depressed, roughly pentagonal in outline, its length about equal to the maximum breadth which is measured across the anterolateral margins of the first glabellar lobes. The frontal glabellar lobe is bluntly pointed frontally, alate, and extends abaxially to the anterolateral tips of the first glabellar lobes where it meets the axial furrows. There are three pairs of glabellar lobes which diminish in size from front to rear. The first glabellar lobes are long, each almost an isosceles triangle in outline ; they are delimited frontally by moderately deep first glabellar furrows which are slightly sigmoidal and widely divergent forwards. The second glabellar lobes are small, only about one-quarter the length of the first pair, and are directed abaxially rearwards parallel to the second glabellar furrows which are shallow, curved, convex forwards, directed slightly rearwards but not reaching the axial furrows, the distal third of the second glabellar lobes being fused with the first pair of lobes. The third glabellar furrows are deep, diverging posteriorly and quickly bifurcating so as to form two branches which isolate the third glabellar

lobes; the latter, slightly smaller than the second lobes, are thus present only as detached tubercles at the distal ends of the basal glabellar segment. The axial furrows are shallow, diverging forwards at 50–55 degrees for most of their length but finally becoming slightly convergent forwards around the anterior end of the first glabellar lobes. The anterior border has not been found preserved, but there appears to be a shallow preglabellar furrow bordering the anterior margin of the frontal glabellar lobe. The occipital furrow is shallow medially, deepening distally where it is flexed backwards and then abaxially so as to accommodate the posterior margins of the third glabellar lobes. The occipital ring is transversely convex, long medially becoming shorter (*exsag.*) distally where it curves forwards slightly to form a pair of ill-defined occipital lobes. Immediately outside the axial furrows the pleuroccipital furrow is moderately deep and broad (*exsag.*), delimiting the narrow (*exsag.*) posterior border which becomes still narrower distally. Neither the furrow nor the border has been found preserved beyond the line of the palpebral lobes. The fixigenae are broad and flat, bounded abaxially by well-defined palpebral furrows; the latter appear narrow on the external mould but broader on the internal mould and extend from near the anterior ends of the first glabellar lobes to the pleuroccipital furrow. The palpebral lobes are broad, flat, level with the fixigenae and crescentic in plan. The ocular surfaces of the eyes have not been found. The anterior branches of the facial suture appear to cut the axial furrows immediately in front of the palpebral lobes; thence they follow the anterolateral margins of the frontal glabellar lobe, converging at its apex. The posterior branches of the suture, together with the outermost parts of the fixigenae, have not been found preserved.

The hypostoma and thorax are unknown.

The pygidium is subtriangular in outline, its median length equal to two-thirds of the maximum breadth which is measured across the almost straight anterior margin; it tapers to a blunt, slightly upturned point, the extreme tip of which has not been seen intact. The axis occupies just less than one-third of the frontal breadth of the pygidium and its sides converge rearwards for about two-thirds of their length, after which they continue almost parallel to the tip of the axis. Owing to the state of preservation, in a sandstone, of the holotype pygidium only eight axial rings are visible but other specimens, found in a fine-grained argillaceous matrix, have eleven or twelve rings. The axial rings themselves are slightly sigmoidal in plan, curving back both medially and distally. Beyond the tip of the axis is a low, smooth, postaxial ridge which runs into the terminal point. On each side-lobe of the pygidium there are six well-defined interpleural furrows; these decrease in depth from first to sixth and extend about two-thirds of the distance from the axial furrow to the lateral margin, apparently ending in line with the inner margin of the doublure. An equal number of rib-furrows is present, each commencing about one-third of the distance from the axial furrow to the lateral margin and then turning rearwards markedly until it intersects the margin. The first pair of rib-furrows is deeply defined, but the remainder become progressively fainter towards the tip of the pygidium. A well-developed facet is present anterolaterally on each side-lobe, immediately in front of the first rib-furrow.

Fragmentary evidence suggests that the surface of the test of both glabella and

pygidium, excepting the furrows, is covered with fine, evenly-distributed granules.

HORIZONS AND LOCALITIES. The type-locality is the site of the old quarry, now filled in, at Quarry Field, Gretton, half a mile east of Cardington. The horizon is in decalcified sandstones belonging to the middle third of the Actonian Stage. The species has also been found in the disused quarries 80 yards south-east and 250 yards east of St. Margaret's Church, Acton Scott. At one time *Calyptaulax actonensis* was thought to occur only in the middle Actonian of south Shropshire (Dean, 1958 : 211), but whilst it is still true that the species is most abundant at this level, it has now been found in the lowest Actonian strata at the large exposure in the south bank of the River Onny about 85 yards west of its junction with Batch Gutter stream, and also in the topmost Actonian and basal Onnian beds exposed in the north bank of the Onny about 30 yards east of the same river/stream junction. Specimens are rare at these latter localities and have not been found higher in the succession.

HOLOTYPE. BM. In. 49771 (Pl. 50, figs. 11, 14).

PARATYPES. BM. In. 48492 (Pl. 50, fig. 13) ; BM. In. 49318 (Pl. 51, fig. 1) ; BM. In. 49768 (Pl. 51, fig. 2).

DISCUSSION. *Calyptaulax* is a predominantly North American trilobite genus and is figured here for the first time from Shropshire. *C. actonensis* bears some resemblance to *C. altumi* as figured by Wiman (1907, pl. 8, figs. 7-10) but differs in having slightly wider fixigenae and a longer pygidium. I am indebted to Dr. Valdar Jaanusson of Uppsala University for the opportunity of comparing my Shropshire specimens with material collected from a South Bothnian drift boulder and determined by Professor Wiman as *C. altumi* (Remelé). Dr. Jaanusson kindly informs me these specimens are derived from strata belonging to the zone of *Pleurograptus linearis*, that is to say, beds younger than those of south Shropshire which belong to the zone of *Dicranograptus clingani*.

The cranidium of the Norwegian species *Calyptaulax norvegicus* (Størmer, 1945 : 417, pl. 4, figs. 2, 3) is virtually indistinguishable from that of *C. actonensis*, but the pygidium differs in having a narrower, more uniformly tapered axis with slightly longer (*sag.*) axial rings. In outline the pygidium of the new species resembles that figured by Jaanusson (1953 : 103, fig. 4) as *Homalops* cf. *altumi* Remelé from the Slandrom Limestone of Dalarne, a horizon belonging to the zone of *Pleurograptus linearis* but containing, nevertheless, a fauna resembling in many respects that of the Actonian Stage in South Shropshire. The Swedish pygidium is incomplete but appears to have fewer axial rings and, probably, rib-furrows.

Under the name "Subgenus A" Struve (*in* Moore, 1959 : 0.491, 492) has recently separated from *Calyptaulax* (*s.s.*) a cranidium of *Calyptaulax altumi* from a Pleistocene erratic in Sweden, together with the pygidium recorded from the Slandrom Limestone by Jaanusson as *Homalops* cf. *altumi* and noted above. The latter pygidium compares closely with that of *C. actonensis*, a species which, in turn, possesses a cranidium indistinguishable, even subgenerically in the writer's opinion, from the type-species of *Calyptaulax*. According to Struve's illustration the cranidium of "Subgenus A" possesses palpebral lobes which become markedly narrow frontally and second glabellar lobes which are present only as detached tubercles. These features may possibly merit subgeneric separation but they have not yet been fully

investigated and are not, in fact, present on the specimens of *C. altumi* lent by Dr. Jaanusson, which are best grouped with *Calyptaulax* (s.s.). *Calyptaulax compressa* (Cooper, 1930, pl. 5, figs. 7, 8) has a shorter glabella and smaller fixigenae than *C. actonensis*, whilst *C. glabella* (Cooper, 1930, pl. 5, figs. 9-11) has only nine well-defined axial rings on the pygidium. *C. schucherti* Troedsson (1929, pl. 19, figs. 17-20) from the Cape Calhoun Formation of Greenland may be distinguished from the Shropshire species by its shorter frontal lobe and smaller fixigenae and first glabellar lobes.

Subfamily CHASMOPSINAE Pillet, 1954

Genus *CHASMOPS* M'Coy, 1849

TYPE SPECIES. *Calymene odini* Eichwald, 1840 by original designation of M'Coy (1849: 403).

Chasmops extensa (Boeck)

(Pl. 51, figs. 3-10; Pl. 52, figs. 1, 3, 4, 6, 7)

- 1838. *Trilobites extensus* Boeck, p. 139.
- 1839. *Asaphus Powisii* Murchison, p. 661, pl. 23, fig. 9a and b only.
- 1848. *Dalmania affinis* Salter, p. 337, pl. 5, fig. 5.
- 1849. *Phacops truncato-caudatus* var. β , *affinis* Salter, p. 7.
- 1851. *Odontochile truncato-caudata* (Portlock) M'Coy in Sedgwick & M'Coy, p. 162, pl. 16, figs. 20, ? 21.
- 1853. *Phacops conophthalmus* (Boeck) : Salter, pp. 7, 11.
- 1854. *Phacops conophthalmus* (Boeck) : Murchison, pl. 4, figs. 11, 12.
- 1854. *Phacops conophthalmus* (Boeck) : Salter & Aveline, p. 67.
- 1854. *Phacops truncato-caudatus* (Portlock) : Salter & Aveline, p. 67.
- 1859. *Phacops conophthalmus* (Boeck) : Murchison, pl. 4, figs. 11, 12.
- 1864. *Phacops* (*Chasmops*) *macroura* Sjögren : Salter, p. 37, pl. 4, figs. 18-23.
- 1864. *Phacops* (*Chasmops*) *conophthalmus* Boeck? (pars), Salter, p. 40, pl. 4, fig. 24.
- 1867. *Phacops conophthalmus* (Boeck) ; Murchison, pl. 4, figs. 11, 12.
- 1872. *Phacops conophthalmus* (Boeck) : Murchison, pl. 4, figs. 11, 12.
- 1884. *Phacops conicophthalmus* (Boeck) : La Touche, p. 57, pl. 3, figs. 65, 65a.
- 1884. *Phacops macroura* Sjögren : La Touche, p. 57, pl. 3, fig. 66.
- 1938. *Chasmops* cf. *macroura* (Sjögren) : Stubblefield in Pocock *et al.*, pp. 90, 255.
- 1940. *Chasmops extensa* (Boeck) : Størmer, p. 138, pl. 4, figs. 7-11.
- 1945. *Chasmops macroura* (Sjögren) : Bancroft, p. 183.
- 1953. *Chasmops extensa* (Boeck) : Størmer, pp. 65, 68-69, 87, 130, 134.
- 1958. *Chasmops* sp., Dean, pp. 222-224.
- 1959a. *Chasmops extensa* (Boeck) : Dean, p. 221.

DESCRIPTION. The cephalon is longitudinally and transversely convex with median length almost three-fifths of the maximum breadth. The glabella is large, almost subpentagonal in outline, strongly convex, its length about three-quarters of the maximum breadth measured across the frontal glabellar lobe. There are three pairs of lateral glabellar lobes. The first glabellar furrows diverge forwards at about 110 degrees; at their mid-points they are slightly concave forwards but abaxially they curve sharply backwards through almost a right angle, becoming deeper and finally cutting the axial furrows. The first glabellar lobes are extremely large by comparison

with the other pairs of lobes ; they are roughly triangular in plan, expanding enormously in length (*exsag.*) from just in front of the second glabellar lobes and indenting the frontal glabellar lobe posterolaterally. Behind the first glabellar lobes a pair of deep furrows extends adaxially, finally bifurcating to form the second and third glabellar furrows which appear then as notches delimiting, both frontally and posteriorly, the small tubercle-like projections which serve as second glabellar lobes. Third glabellar lobes are represented by the slightly curved-forwards, posterolateral extremities of a basal glabellar segment which extends abaxially almost to the posterior ends of the first glabellar lobes. When preserved as internal moulds the third glabellar lobes appear as almost detached, rounded, knob-like projections. The frontal glabellar lobe is large, strongly convex, and broadest frontally where the breadth is about twice the length. Occasionally, cephalae of *Chasmops extensa* preserved as internal moulds exhibit a V-shaped group of tubercles, directed backwards and extending from the preglabellar furrow to a position opposite the frontal portion of the first glabellar lobes. This structure was noted in specimens from Shropshire by Salter (1864 : 39, pl. 4, fig. 20), and a similar feature has been figured by Harrington (*in* Moore, 1959, fig. 69E) for *Chasmops odini* (Eichwald) from Estonia and termed "auxiliary impressions", the exact function of which is not yet clear. Schmidt (1881, pl. 2, figs. 2, 3, 10 ; pl. 5, figs. 1, 9) has figured analogous structures in other species of *Chasmops*. The frontal margin of the frontal glabellar lobe is indented medially by a deep, broad (*sag.*) preglabellar furrow which curves gently forwards and then slightly backwards abaxially, at the same time becoming shallower and almost dying-out where it meets the axial furrows. The latter diverge forwards at an average angle of about 40 degrees but are laterally convex in part so as to accommodate the distal margins of the first glabellar lobes ; they are generally deep and narrow but become markedly shallower medially, just to the rear of centre of the first glabellar lobes. The preglabellar field is convex, becoming thicker medially, coincident with the concave margin of the frontal glabellar lobe ; distally it narrows (*exsag.*) slightly, and then maintains a uniform breadth along the anterior margin of the frontal glabellar lobe, finally curving around the tips of the latter to meet the axial furrows. The anterior border furrow is narrow (*sag.*) frontally, becoming broader and shallow abaxially where it curves sharply backwards to intersect the axial furrows. The anterior border is uniformly convex forwards in plan and has a flattened upper surface declined frontally ; the breadth (*sag.*) is generally uniform but at the line of the axial furrows it expands to form V-shaped projections extending into the anterior parts of the axial furrows themselves. Beyond the axial furrows the border narrows (*exsag.*) again and is separated from the fixigenae by broad (*tr.*), moderately-deep lateral furrows which extend rearwards to meet the distal ends of the pleuroccipital furrow. The occipital ring is long (*sag.*), transversely convex but flattened longitudinally, curving forwards distally to form a pair of large occipital lobes which are poorly defined laterally by the ends of the axial furrows. The occipital ring is bordered frontally by a deep, uniformly broad (*sag.*) occipital furrow. The pleuroccipital furrow is deep and broad (*exsag.*), curving rearwards slightly distally where it intersects the shallower lateral border furrows without reaching the lateral margins. The posterior border is narrow (*exsag.*) immediately

outside the axial furrows, becoming still narrower mid-way to the lateral margins and then expanding rapidly towards the genal angles which are produced backwards to form large fixigenal spines. The latter are about as long as the cephalon (*sag.*) and their upper surface is flattened, declined distally at almost a right angle; the lateral margins are longitudinally straight and the proximal margins run abaxially backwards to meet them and form pointed tips. The smaller, proximal halves of the fixigenae decline steeply from the palpebral lobes to the axial furrows; the distal halves are plump, quadrant shaped, and steeply declined to the lateral border furrows. The schizochroal eyes are semicircular in plan, standing higher than the median lobe of the glabella; they are highest medially, becoming lower both anteriorly and posteriorly, and the visual surface is steeply declined abaxially. The eyes are not generally preserved whole, but the left eye of a cephalon, In. 52166, with a median length of 32 mm. possesses 350 facets arranged in twenty-nine vertical rows containing from four to sixteen facets. Immediately below each eye there is a broad, pronounced eye platform, as long as and parallel to the visual surface. The palpebral lobes are broad, strongly convex distally in plan, steeply declined adaxially and delimited by deep, broad palpebral furrows. Each palpebral furrow follows an outwardly-directed, V-shaped course above the apex of the eye, curving around both ends of the eye to join the eye-platform below. The anterior branches of the facial suture run almost straight forwards from the eyes, cutting first the eye-platforms near their anterior ends, crossing the fixigenae, and cutting the axial furrows mid-way between the distal ends of the first glabellar furrows and the lateral extremities of the frontal glabellar lobe; they follow the axial furrows forwards and then curve sharply adaxially, first cutting the preglabellar field and finally coinciding with the anterior border furrow until they meet frontally. The posterior branches of the facial suture are placed in shallow grooves suggestive of those found in the other phacopid genera *Pterygometopus* and *Estoniops*, and run abaxially from the rear ends of the eyes, at first almost straight, cutting the eye-platforms; they then curve gently forwards and, finally, more markedly rearwards, meeting the lateral margins at a sharply acute angle.

The surface of the glabella and, to a lesser degree, of the occipital ring is covered with scattered, coarse tubercles each of which, on magnification (see Pl. 52, fig. 6), is seen to comprise a cluster, generally about fifteen to twenty-five, of smaller granules. Granules of similar size are thinly distributed between the tubercles, and become still sparser across the proximal ends of the first glabellar lobes. The surface of the preglabellar field is conspicuously distinct from that of the glabella, being covered with closely-set, uniformly distributed granules (Pl. 52, fig. 1). A similar ornamentation is found on the test of the anterior border (not preserved in Pl. 52, fig. 1) and extends posterolaterally along the lateral borders. The proximal surface of the librigenae is similar to that of the glabella, but the tubercles are less well defined. The test of the posterior border is finely granulate, particularly the anterior half which appears almost smooth. Abaxially all the granules disappear and the test of the genal spines is quite smooth. The deepest parts of all the cephalic furrows, together with the proximal parts of the eye-platforms, are also smooth.

The hypostoma, rarely found unbroken, is roughly triangular in plan, its maximum

breadth, measured across the anterior wings, approximately equal to, or slightly less than, the median length. The anterior border, barely differentiated from the median body, is rounded, convex forwards, and continuous in line with the anterior wings which form conspicuous lateral projections and are twisted through almost a right-angle near their tips. A short distance behind the anterior wings is a pair of ill-defined projections which probably represent attenuated posterior wings. The lateral border is narrow, passing into the posterior border which forms a flattened, bluntly pointed, spatulate extension occupying almost one-quarter of the median length of the hypostoma. The median lobe is moderately tumid, about three-quarters of the total length, narrowing rearwards where it is delimited by the transverse median furrow. The last-named is almost obsolete medially but deepens laterally where it runs forwards to meet the lateral border just to the rear of the anterior wings. Immediately behind, and parallel to, the transverse median furrow is a narrow posterior lobe, poorly defined medially but expanding laterally and forwards to give rise to a pair of oblique maculae sited opposite and just to the rear of the posterior wings. A shallow, posterior transverse furrow, also parallel to the transverse median furrow, separates the posterior lobe from the posterior border and becomes deeper laterally and forwards. A few better-preserved specimens show traces of coarse tubercles on the ventral surface of the median lobe.

The thorax is known so far from only a few incomplete segments, none of which has the tips preserved. Each axial ring is of similar size to the occipital ring, being transversely broad and convex but longitudinally flat; the anterior and posterior margins are, for the most part, transversely parallel except near the deep axial furrows where the distal portions curve forwards slightly to form a pair of small lobes. The articulating half-ring is large, about two-thirds the length (*sag.*) of the axial ring, from which it is separated by a deep, narrow (*sag.*) articulating furrow. Each pleura is of uniform breadth (*exsag.*), equal to that of the axial ring, as far as the fulcrum, beyond which point its form is not known. A deep, narrow (*exsag.*) pleural furrow commences at the junction of the anterior margin with the axial furrow, then curves gently and abaxially back as far as the fulcrum where it begins to curve forwards again, its subsequent course being unknown.

The pygidium is large, elongate, subparabolic in outline, its anterior margin only gently convex forwards. Strongly arched transversely, and gently declined posteriorly, it terminates in a bluntly-pointed, slightly upturned tip. Frontally the axis occupies about one-third of the projected breadth, is straight-sided, and tapers uniformly rearwards, extending for about five-sixths of the length of the pygidium. The axial furrows are, for the most part, well defined but become obsolete near the end of the axis which passes into a transversely convex postaxial ridge extending to the tip of the pygidium. The largest available specimen, about 36 mm. long, has sixteen axial rings which do not reach the tip of the axis. The ring-furrows are generally well defined, becoming less so after about the twelfth, and some of the first few axial rings have their posterior margins indented medially, revealing what would be the corresponding articulating half-ring on the unfused segments of the thoracic axis (see Pl. 51, figs. 5, 7). Each side-lobe carries up to sixteen ribs which become progressively less transverse in direction from front to rear until the

final rib is parallel to the sagittal line. The ribs are separated by deep, narrow (*exsag.*) pleural furrows which are gently sigmoidal in plan and become almost obsolete at what is probably the inner margin of the doublure, so that an almost smooth border results. The hindmost pleural furrows are fainter than the rest and the final pair encroaches upon the sides of the postaxial ridge which may, in consequence, have a slightly waist-like appearance. Each rib is divided into two almost equal bands by a faint interpleural furrow which commences at the junction of the posterior margin of the rib with the axial furrow (see Pl. 52, fig. 7) and does not extend so far distally as do the adjacent pleural furrows. The pygidial margin is entire, arched upwards strongly at the tip. The surface of each axial ring is covered with fine, evenly-distributed granules at and near the sagittal line. Similar granules cover the surface of the posterior band of each rib but tend to die away on the anterior band (see Pl. 52, fig. 7). The border and postaxial ridge are also finely granulate but the axial furrows and articulating furrow are quite smooth.

HORIZONS AND LOCALITIES. The earliest known specimens of *Chasmops extensa* in south Shropshire have been collected from the upper portion of the Upper Longvillian Substage, the Lower Cheney Longville Flags. At this horizon *C. extensa*, though not abundant, is found in association with *Kjaerina typa* Bancroft, *Dolerorthis duftonensis* (Reed) and *Kloucekia* (*Phacopidina*) *apiculata* (M'Coy). It may be found at a number of localities along the River Onny Valley, about a mile south-east of Horderley Station, and along Longville Lane, between 35 and 120 yards north-west of the Earthwork at Cheney Longville.

The species is more abundant in the Marshbrookian Stage, or Upper Cheney Longville Flags, particularly the lowest two-thirds. At this horizon it is to be found throughout much of the Caradoc Area, the most prolific localities including: the Onny Valley east of Burrells Coppice, south-east of Horderley; the exposure 250 feet north-north-east of Woolston House, Woolston; numerous exposures in the vicinity of Marshbrook, including the well-known Marsh Wood quarry; and the stream-section 550 yards south-south-west of Common Farm, Wallsbank.

Chasmops extensa occurs sporadically throughout the mudstones of the Actonian Stage in the Onny Valley, north-east of Cheney Longville, certain levels being occasionally marked by an abundance of individuals. Some of these may attain a large size and frequently have the test preserved. Northwards from the Onny the species is to be found at many places where the Actonian Stage crops out, but generally tends to be less abundant in the arenaceous rocks of the Stage. Localities include: the south bank of the River Onny about 80 yards west of its junction with Batch Gutter stream; the upper reaches of Batch Gutter itself, half a mile north-west of Wistanstow; various quarries in the vicinity of Acton Scott village; exposures around the village of Plais, 5 miles north-east of Church Stretton; and the old quarry (now filled in) at Gretton, half a mile east of Cardington. The last two of these are in the arenaceous development of the Acton Scott Beds, probably representing the middle part of the Actonian Stage.

The stratigraphically youngest specimens of *Chasmops extensa* in south Shropshire are known from the lowest zone of the Onnian Stage in the Onny Valley, in association with *Onnia? cobboldi* (Bancroft). A typical locality is in the north

bank of the river 35 yards east of its junction with the stream of Batch Gutter.

FIGURED SPECIMENS. BM. In. 49126 (Pl. 51, fig. 6) ; BM. In. 49127 (Pl. 51, figs. 4, 8, 10 ; Pl. 52, figs. 1, 6) ; BM. In. 49128 (Pl. 51, figs. 5, 9 ; Pl. 52, fig. 7) ; BM. In. 50546 (Pl. 51, fig. 7) ; BM. In. 50547 (Pl. 51, fig. 3) ; BM. In. 50548 (Pl. 52, fig. 4) ; BM. In. 50549 (Pl. 52, fig. 3).

DISCUSSION. *Chasmops extensa* was first introduced as a species by Boeck (1838) but the name was allowed to lapse from general usage until revived more recently by Størmer (1940 : 138) who has figured the lectotype from Gaasøen, near Oslo. In southern Norway the species is characteristic of the Upper Chasmops Shale (4bγ) and the Upper Chasmops Limestone (4bδ), a vertical range broadly comparable with that found in south Shropshire. It has been suggested by Størmer that *Chasmops macroura*, from Sweden, may be synonymous with *C. extensa*, but the problem is not yet resolved owing to lack of detailed information on the type specimen of *C. macroura*. The Swedish species was first described and figured by Angelin (1854 : 9, pl. 7, figs. 3, 4) but he attributed the name to Sjögren who has since been generally accepted as its author. Howell (1951 : 299) has pointed out that no evidence exists to show that Sjögren's was anything more than a manuscript name and Angelin must accordingly be considered the author.

The material from the Lower Cheney Longville Flags of Shropshire agrees well with Størmer's illustrations of the lectotype of *C. extensa*, and the Shropshire specimens from this horizon are only slightly larger. Specimens from the Actonian Stage of the Onny Valley frequently attain much larger dimensions but this is not considered to be more than a local variation, perhaps the result of a more favourable environment.

Warburg (1925 : 402) considered *Chasmops maxima* (Schmidt, 1881 : 112) to be identical with *C. macroura*, but according to Størmer (1945 : 421) the former may justifiably be regarded as a distinct species on account of the longer, deeper axial furrows of the pygidium. The specimens, including the pygidium, of *C. maxima* illustrated by Størmer (1945, pl. 2, figs. 1-5) show such a strong resemblance to *C. extensa* that the former may well be no more than a subspecies or variety of the latter, if not actually conspecific with it.

Salter (1864 : 41) recorded what he called "*Phacops (Chasmops) conophthalmus* (sic) Boeck" from the Caradoc Series of "Acton Scott". This species, the lectotype of which has been refigured by Størmer (1940, pl. 3, figs. 1-6), is more correctly called *Chasmops conicophthalma* (Sars & Boeck), and is characteristic of the Lower Chasmops Shale (4bα) and the Lower Chasmops Limestone (4bβ) in southern Norway. One of the most conspicuous differences between this species and *C. extensa* is the former's possession of a short, rounded pygidium, contrasting with the elongated pygidium of the latter species. Specimens of *Chasmops* with somewhat similar, short pygidia have been collected from the Lower Longvillian Substage of the Cross Fell Inlier and North Wales, but as far as is known no genuine *C. conicophthalma* has yet been recovered from the Caradoc of Great Britain.

Chasmops amphora was founded by Salter (1853 : 12 ; 1864 : 42, pl. 4, fig. 16) on a large pygidium from the Crûg (= Crugg or Grug) Limestone of the Llandilo district of South Wales, a horizon stated by Williams (1953 : 195) to be Longvillian to Marsh-

brookian in age. The associated fauna includes *Atractopyge*, *Illaenus*, *Leptaena*, *Nicolella* and *Onniella*?, an assemblage which suggests that the limestone, at least in part, might well prove to include strata as high as Actonian in age. At all events, *C. amphora* appears to be generally contemporaneous with *C. extensa* as found in Shropshire. An undoubted cephalon of *C. amphora* has apparently never been figured, but cranidia of *Chasmops* recently obtained from the Crûg Limestone are remarkably close to those of *C. extensa* and it is therefore possible that the two species may occur in association, though the pygidium of the latter species has yet to be found in South Wales. The pygidium of *C. amphora* is easily recognized by its tumid form which is more strongly arched, both longitudinally and transversely, than that of *C. extensa*, by its more rounded tip, and by the pleural furrows which, on the holotype at least, appear to be pitted and which are more strongly defined both at and across the otherwise smooth border.

Chasmops salopiensis sp. nov.

(Pl. 52, figs. 2?, 5)

DIAGNOSIS. Glabella of distinctive shape, triangular in plan, narrowing backwards markedly to small occipital ring. First glabellar lobes small. Frontal glabellar lobe large, long, about two-thirds median length of glabella.

DESCRIPTION. The cephalon is roughly semicircular in outline, its median length less than half the maximum breadth. The glabella is moderately convex, both longitudinally and transversely, broader than long in the ratio of about 3:2, and roughly triangular in outline. It is bounded abaxially by almost straight axial furrows which diverge forwards at about 55 degrees; these become shallower medially, where they are constricted slightly opposite the first and second glabellar furrows. The frontal glabellar lobe is large, alate, subtriangular in outline, about twice as broad as long, and occupying more than half the median length of the glabella. The first glabellar furrows are deep, almost straight, and diverge anteriorly at 125 degrees; the first glabellar lobes, each roughly the shape of an isosceles triangle, occupy one-third of the length of the glabella, and are connected to the central lobe of the glabella by narrow "necks". The second glabellar furrows are short (*tr.*), deep, and converge anteriorly at about 70 degrees; second glabellar lobes are sited at the distal ends of the second furrows and are represented by a pair of small tubercles, one at either end of a poorly-defined glabellar segment. The third glabellar furrows are barely visible small notches, and the third glabellar lobes are formed at the abaxial extremities of a small, basal glabellar segment which is slightly more conspicuous than that immediately in front. The occipital furrow is transversely straight, of moderate depth medially but becoming deeper abaxially where it ends in a pair of deep apodemal pits. The occipital ring is incompletely known, but is small, transversely convex, and apparently of small size. The posterior median lobe of the glabella is conspicuously narrow, equal to only one-sixth of the maximum breadth of the frontal glabellar lobe. The preglabellar field, though not conspicuous, is best developed medially, becoming narrower (*exsag.*) abaxially where it follows the outline of the frontal glabellar lobe until it is truncated by the axial

furrows. Frontally the preglabellar field is delimited by a shallow, narrow (*exsag.*) anterior border furrow which runs parallel to the preglabellar furrow until it intersects the axial furrows. The anterior border is narrow (*sag.*), reflexed so as to produce a bluntly-rounded cross-section, and broadens (*exsag.*) distally where it passes without interruption into the lateral border. The latter is delimited by deep, broad lateral border furrows which run parallel to the lateral margin from the axial furrows. The posterior border furrows are narrow (*exsag.*) and moderately deep towards the axial furrows, but they widen abaxially and finally intersect the lateral border furrows. Near the axial furrows the posterior border at first narrows (*exsag.*) and then becomes parallel-sided, but at the posterolateral angles it increases in size abruptly and is produced rearwards to form a pair of large, tapering fixigenal spines. The upper surface of each spine is steeply declined outwards, its abaxial margin continuous with that of the lateral borders, and the length of each spine is at least equal to that of the cranidium at the sagittal line.

The proximal parts of the fixigenae are narrow and declined steeply from the palpebral lobes to the axial furrows; they are surmounted by conspicuous, reniform, palpebral lobes set high above the level of the glabella and separated from the fixigenae by broad, well-defined, palpebral furrows. The schizochroal eyes are large, their visual surfaces steeply declined distally, and they extend from points in line with the adaxial ends of the first glabellar furrows until they are opposite the third glabellar lobes. The visual surface of the right eye of the holotype is partly preserved, though slightly displaced from its normal position. At least fifteen vertical rows of facets are visible as far as the mid-point of the palpebral lobe, so that about thirty rows must originally have been present. The number of facets in each row, as far as can be judged, varies from five to thirteen. The anterior branches of the facial suture run almost straight forwards from the eyes to cut the axial furrows, diverge forwards around the distal ends of the frontal glabella lobe, and finally converge to meet frontally, their course beyond the axial furrows almost coinciding with that of the anterior border furrow. The posterior branches run outwards from the eyes, arching first forwards and then rearwards until they cut the lateral border at an acute angle roughly in line with the third glabellar lobes. Immediately below each eye, and equal in length to the latter, is a well-defined, level, eye platform from which the main convex part of the librigena is steeply declined as far as the lateral border furrow.

The surface of the test of the glabella and fixigenae is only partly known but most of it, at least, is ornamented with what appear to be large dispersed tubercles. As in the case of *Chasmops extensa* (see p. 333) each of these is seen, on magnification, to consist of a group of closely-packed, smaller granules, others of which are dispersed over the intervening spaces. The surface of the preglabellar field, anterior border and lateral border is granulate, but that of the various cephalic furrows and the genal spines is smooth.

The hypostoma and thorax are not known.

One fairly complete pygidium of *Chasmops* has been found in association with the holotype cephalon of *C. salopiensis* and may belong to the species. It is subparabolic in outline and, in spite of some crushing, is apparently strongly convex transversely.

and about as long as broad. The axis, which carries sixteen axial rings, is bounded laterally by deep axial furrows along the whole of its length. In plan the axis tapers gently, ends in a bluntly rounded tip, and does not extend the whole length of the pygidium, being followed posteriorly by a small postaxial ridge. Each side-lobe carries sixteen ribs, the hindmost of which are only poorly defined. The ribs are separated by moderately deep pleural furrows which extend uniformly abaxially as far as the inner margin of the doublure, when they become suddenly shallower and fainter, at the same time curving back to the lateral margins. The pairs of ribs become progressively less divergent rearwards until the final, poorly-defined pair runs almost parallel to, and delimits, the postaxial ridge. The test of the pygidium is imperfectly known, but near the lateral margin appears to be finely granulate.

HORIZON AND LOCALITY. The specimens described were collected from a 3-inch band containing fragmentary trilobites and brachiopods in the north bank of the River Onny, about 30 yards east of its junction with the stream from Batch Gutter. The associated fauna includes *Platylichas*, *Remopleurides*, *Tretaspis*, *Onniella* and *Sampo*. The horizon is in the topmost part of the Actonian Stage and the species has not yet been found elsewhere.

HOLOTYPE. BM. In. 50551 (Pl. 52, fig. 5).

DISCUSSION. *Chasmops salopiensis* is probably most closely related to *C. extensa* but its cephalon may be distinguished by its longer and proportionately larger frontal glabellar lobe, the smaller first glabellar lobes, the narrower posterior portion of the glabella with its smaller occipital ring, and by the straighter axial furrows.

The pygidium which is tentatively assigned to the new species appears to have a narrower axis than that of *C. extensa*, but the specimen is not well preserved and so has not been included as type-material.

Family HOMALONOTIDAE Chapman, 1890

Genus *PLATYCORYPHE* Foerste, 1919

Some of the south Shropshire trilobites now assigned to *Platycoryphe* have been referred previously to *Eohomalonotus* Reed, 1918. The latter genus, together with *Calymenella* Bergeron, 1890, has been discussed by Prantl & Přibyl (1948) and Szűzy (1957). The former authors regarded *Calymenella* as a subgenus of *Eohomalonotus*, whilst the latter author believed the reverse to be true on the grounds that *Calymenella* was the earlier described genus. Szűzy's views have since been reiterated (in Moore, 1959 : 0.484). The evidence for separating *Calymenella* and *Eohomalonotus* seems to be tenuous and Whittard (1960 : 162) regards them as synonymous, but both are typically genera differing markedly from the south Shropshire forms; certain of the latter are, in turn, remarkably close to the type-species of the North American genus *Platycoryphe*. Recently this name has been placed by Henningsmoen (in Moore, 1959 : 0.524) with the trilobites whose Order and Family are doubtful, but Whittard (1961 : 163) has used it to include certain Ordovician Homalonotidae from the Shelve Inlier, west Shropshire, and it is regarded here as being best grouped with

Calymenella and related genera. *Platycoryphe* is recorded from such widely-scattered regions as Bohemia, Shropshire and eastern North America, all the known occurrences being of Middle or Upper Ordovician age.

***Platycoryphe dentata* sp. nov.**

(Pl. 53, figs. 1-7, 9, 13; Pl. 55, figs. 3, 10)

- 1854. *Homalonotus rudis* M'Coy: Salter & Aveline, p. 65.
- 1865. *Homalonotus rudis* M'Coy: Salter, pl. 10, fig. 11.
- 1865a. *Homalonotus rudis* M'Coy: Salter, pl. 10, fig. 13.
- 1873. *Homalonotus rudis* M'Coy: Salter, p. 53.
- 1918. *Homalonotus biserratus* (pars). Reed, p. 273. MS. name only.
- 1938. "*Homalonotus*" cf. *bohemicus* Barrande: Stubblefield in Pocock *et al.*, p. 255.
- 1939. *Eohomalonotus*? cf. *bohemicus* (Barrande) Stubblefield, p. 55.
- 1958. *Eohomalonotus* sp., Dean, p. 218.

DIAGNOSIS. *Platycoryphe* with three well-defined pairs of glabellar lobes. Distinct paraglabellar areas present. Tumid pygidium with six or seven axial rings and five pairs of pleural ribs. Each rib terminates laterally in two tooth-like projections, the anterior of which is the larger, separated from each other by the interpleural furrow.

DESCRIPTION. The cranium is moderately convex transversely, less convex longitudinally, with a maximum breadth generally about equal to its basal breadth, but two, probably dimorphous, forms of the species are present and in the second of these the glabella is conspicuously narrower (see Pl. 53, figs. 3, 9). Such a feature may possibly be of sexual significance. The glabella is gently convex, subtrapezoidal in outline, with three pairs of well-defined glabellar lobes. The frontal glabellar lobe is subquadrate in plan with a slightly convex anterior margin and occupies between one-quarter and one-third of the median length of the glabella. The first glabellar furrows are shallow, gently curved, convex forwards, and extend adaxially and slightly rearwards from the axial furrows for about one-quarter of the glabellar breadth. The first glabellar lobes are subquadrate, equal to about one-sixth of the length of the glabella; they are bounded to the rear by the second glabellar furrows which are parallel to, but deeper than, the first pair. The second glabellar lobes are of similar length to the first pair but project beyond them so that the outline of the glabella is broken on either side by a "step" at the second glabellar furrows. The third glabellar furrows are deep and, near the axial furrows, almost parallel to the second glabellar furrows; they then curve adaxially and sharply backwards, extending almost half the length of the third glabellar lobes. The three pairs of glabellar furrows terminate longitudinally in line, parallel to the median line. The third glabellar lobes are about one and a half times as long as the first and second glabellar lobes; they are almost of "cat's ear" form and their abaxial margins are slightly indented. The axial furrows are broad and moderately shallow, becoming still shallower opposite the third glabellar lobes; their rear halves are subparallel as far as the second furrows, in front of which, beyond the break in the glabellar outline described above, they become more strongly convergent forwards. The

frontal glabellar lobe and the anterior portions of the fixigenae are bounded frontally by a broad (*sag.*), moderately-deep, transverse furrow, in front of which rises the anterior border, becoming thicker medially where its apex is bluntly pointed or gently rounded. The occipital furrow is narrow (*sag.*), moderately deep and transversely straight except for its median third where it becomes shallower and slightly convex forwards. The occipital ring is of almost uniform length (*sag.*), equal to about one-sixth that of the glabella, and carries a weakly-developed median node. The pleuroccipital furrow is broad (*exsag.*) and well defined, follows a gently sigmoidal course abaxially from the axial furrows and finally flexes more strongly towards its outer ends. The posterior border is of uniform breadth (*exsag.*) and runs parallel to the posterior border furrow as far as the rounded genal angles. The anterior portions of the fixigenae are equal to or rather more than half the corresponding glabellar breadth; the posterior portions contain well-developed paraglabellar areas which are semicircular in outline and abaxially convex, the breadth of each being about equal to one-quarter of the basal glabellar breadth. Each paraglabellar area is bounded adaxially by the axial furrow and abaxially by a semicircular furrow which meets the axial furrow frontally in a broad, pit-like depression opposite the third glabellar furrow. The palpebral lobes, though imperfectly known, are apparently crescentic in plan, moderately convex abaxially, extending backwards from points level with the first glabellar lobes as far as the line of the third glabellar furrows; their apices are level with the front half of the second glabellar lobes. They are defined adaxially by shallow palpebral furrows which extend from just outside the axial furrows, opposite the mid-points of the first glabellar lobes, until level with the middle of the paraglabellar areas; the furrows then turn through slightly more than a right angle and extend rearwards until they intersect the paraglabellar areas; the furrows then turn through slightly more than a right angle and extend backwards until they intersect the paraglabellar furrows. The anterior branches of the facial suture converge forwards parallel to the axial furrows as far as the anterior margin, where they turn adaxially and meet frontally. The posterior branches extend straight abaxially from the eyes almost half-way to the lateral margins, but then curve backwards through about 60 degrees and finally cut the lateral margins, apparently just in front of the rounded genal angles. The librigenae are not known with certainty, but a large specimen which probably belongs to the species is figured (Pl. 53, fig. 13). This is incompletely preserved but there is a suggestion of an eye-platform, outside of which the librigena is strongly convex and steeply declined towards the thickened border, from which it is separated by a broad, shallow, lateral border furrow.

The hypostoma and thorax are unknown.

The pygidium is tumid, wider than long in the ratio 5 : 3 or thereabouts, with rounded anterior and posterior margins which are strongly convex to front and rear respectively. Frontally the axis occupies about one-third of the maximum breadth of the pygidium, and extends almost to the tip of the latter. The axis is bounded laterally by deep, narrow, axial furrows which converge backwards strongly for about two thirds of their length and then become slightly less convergent as far as the tip; there they join with a shallow but well-defined postaxial groove which separates the axis from the tip of the pygidium. Nearly all the available specimens

have six axial rings, the sixth ring-furrow being shallow medially and obsolete distally. One small specimen (In. 54875) is exceptional in possessing seven axial rings, both the sixth and seventh ring furrows being obsolete distally. The terminal piece of the axis is swollen so as to produce a large, upwardly-directed, tubercle-like projection which is conspicuous even in a crushed specimen. In all the pygidia examined, each side-lobe has five ribs which diminish slightly in size from first to fifth and are separated from each other by deep, narrow (*exsag.*), pleural furrows. Each rib carries a faintly-impressed interpleural furrow which divides the rib into an anterior and a posterior band, the former being about twice as wide (*exsag.*) as the latter. The interpleural furrows are, for the most part, barely visible but each becomes suddenly and markedly deeper near the lateral margin which it intersects. The resulting notches, situated asymmetrically between adjacent pleural furrows, have the effect of producing a series of ten, tooth-like projections, alternately large and small in size, along either margin of the pygidium. There is sometimes a faint suggestion of a further pair of projections to the rear of the fifth pleural furrow.

With the exception of the furrows, the whole of the surface of the dorsal exoskeleton is covered by small, closely-grouped granules. These are particularly conspicuous on the outer surface of the test but less so on internal moulds.

HORIZONS AND LOCALITIES. The strata from which practically all the known specimens of *Platycoryphe dentata* have been collected form the *Harknessella subquadrata* Zone (known also as Beds or Limestone), the topmost subdivision of the Costonian Stage in the northern Caradoc Area. Only an occasional isolated specimen has been found in the succeeding Harnagian Stage of Coundmoor Brook (Pl. 55, fig. 3); this resembles the Costonian material in practically all respects but shows indications of eight axial rings, the seventh ring-furrow being obsolete distally and the eighth furrow still less well defined. The tip of this pygidium appears more prominent than usual owing to crushing which has emphasized the region immediately behind the axis. No specimens have been found in the Costonian of the southern Caradoc Area and only one individual, described later (p. 344) as *P. cf. dentata*, is known from rocks of, presumably, Harnagian age in the Horderley District.

Costonian localities include: the disused quarry in Black Dick's Coppice, Evenwood; the section exposed in Bullhill Gutter, Evenwood; disused quarries in the north-western and north-eastern parts of Round Nursery, south of Harnage Grange; and the old quarry by the south-eastern side of Coundmoor Brook, 1,500 yards south-west of Harnage Farm, Harnage. The Harnagian locality, comprising shales of the *Reuscholithus reuschi* Zone, is in the south bank of Coundmoor Brook, 1,340 yards south-west of Harnage Farm.

HOLOTYPE. GSM. WM. 1335 (Pl. 53, fig. 1).

PARATYPES. GSM. WM. 1371 (Pl. 53, fig. 3); BM. In. 54875 (Pl. 53, figs. 2, 4); BM. In. 54876 (Pl. 53, fig. 5); GSM. WM. 1338 (Pl. 53, fig. 6).

OTHER FIGURED SPECIMENS. BM. In. 54584 (Pl. 53, fig. 7); BM. In. 49310 (Pl. 53, fig. 9); BM. In. 54879 (Pl. 53, fig. 13); BM. In. 54913 (Pl. 53, fig. 3); BM. In. 54880 (Pl. 54, fig. 5); BM. In. 54325 (Pl. 55, fig. 3); GSM. 35516 (Pl. 55, fig. 10).

DISCUSSION. The manuscript name *Homalonotus biserratus* was applied by Reed (1918: 273) to specimens, from the Hoar Edge Grits (of Costonian age) near Harnage,

which had earlier been thought by Salter (1865*a*; pl. 10, fig. 13) to belong to *Homalonotus rudis*. The specific name used by Reed referred to the saw-like margins of the pygidium and he almost certainly had in mind the new species. He appears, however, to have used the name to include all the homalonotids of the Hoar Edge Grits and another specimen, a cranidium Sedgwick Mus. A. 43966 (Pl. 55, fig. 2), labelled by him as belonging to the same manuscript species is now known to be a typical *Brongniartella* and elsewhere in this paper is made one of the paratypes of *B. caradociana* sp. nov.

Platycoryphe dentata is close to the Czech species *P. bohémica* (Barrande, 1852: 580, pl. 34, figs. 40-42; 1872: 37, pl. 1, figs. 6, 7) from the Drabov Quartzites, of Llandeilo age. This species was re-examined by Prantl & Přibyl (1948: 7) and placed in *Eohomalonotus*. The figures of the Bohemian form suggest some variation in the proportions of the glabella, but none shows any trace of paraglabellar areas such as are strongly developed in the Shropshire species. The pygidium of *P. bohémica* bears a general resemblance to that of *P. dentata* and possesses a similar number of both axial rings (six or seven) and pleural ribs (five or six), the sixth and seventh axial rings becoming obsolete distally. The terminal piece of the pygidial axis in most figured examples of *P. bohémica* lacks the conspicuously tumid form found in the Shropshire species, though one specimen (Barrande, 1852, pl. 34, fig. 41) shows a weak development of this feature. The lateral margins of the pygidium are smooth, contrasting strongly with the serrated margins of *P. dentata*.

The type-species of *Platycoryphe* was first described by Foerste (1910: 81-82, pl. 2, fig. 7) as *Calymene platycephala* and was founded by him on a single cranidium. In many respects the latter resembles that of *P. dentata* but differs in having an "unstepped" glabellar outline, narrower fixigenae frontally, and a smaller, narrower (*tr.*), anterior border. There is a possible trace of a paraglabellar area on the right fixigena but the preservation of both fixigenae is too poor to be certain. A fragmentary pygidium tentatively assigned to *P. platycephala* (Foerste, 1910, pl. 4, fig. 21) has a narrower axis than that of *P. dentata*, with at least six axial rings. The pleural lobes have a larger number of ribs, six pairs, with a suggestion of a seventh pair; there is no trace of serrations along the lateral margins. The specimens of *P. platycephala* originated from the Saltillo Limestone of Tennessee, a horizon which Foerste (1910: 19) described as the stratal equivalent of the Hermitage Limestone, of middle Trenton age. The North American species is thus somewhat later in age than the south Shropshire specimens.

Platycoryphe dubia (Savage, 1913: 60, pl. 2, figs. 8, 9; Foerste, 1919: 395, pl. 19, figs. 15*a*, *b*) from the Girardeau Limestone (Richmondian) of Illinois differs markedly from all the above species. The axial furrows are uniformly convergent forwards, the basal glabellar lobes are smaller, bounded by straight third glabellar furrows, and paraglabellar areas are not developed. The front of the pygidium is only slightly convex forwards and the pleural furrows do not reach the margins. The species may only tentatively be retained in *Platycoryphe*.

Recently Whittard (1961: 164, pl. 22, figs. 8-19) has redescribed and figured *Platycoryphe vulcani* (Murchison) from the Weston Beds (high Llanvirn Series) of the Shelve Inlier, west Shropshire. This species is conspicuously different from

P. dentata, possessing a more trapezoidal glabellar outline with less well-developed glabellar furrows, and lacking paraglabellar areas and serrated pygidial margins. Some of the specimens figured by Whittard are difficult to distinguish from *Brongniartella*, and a reappraisal of the distribution of *Platycoryphe* in Britain must await the redescription of the type-species.

Two specimens are figured in this paper as *Platycoryphe* cf. *dentata* ; although they probably belong to that species, some doubt persists owing to the state of preservation.

Specimen BM. In. 51726 (Pl. 53, fig. 8) is a flattened, internal mould of an incomplete cranidium, the anterior border and palpebral lobes of which are missing. The glabellar outline is elongated and subtrapezoidal, and the axial furrows are almost straight. The second glabellar lobes are longitudinally in line with the first and third pairs of lobes and lack the distally projecting outline of those of *P. dentata*, but such modification might be the result of crushing. Despite the absence of the palpebral lobes the position of the eyes seems to be as in *P. dentata*, and the three pairs of glabellar furrows are of similar type, though somewhat distorted. BM. 51726 is from the Neptunian dyke in the north-eastern corner of the disused quarry on the south side of Hazler Hill, east of Church Stretton. The country rock forms part of the Eastern Uriconian (Pre-Cambrian) and the fissure infilling contains a fauna of early Harnagian age, equivalent to the zone of *Reuscholithus reuschi*, though the zonal trilobite has not been found there.

Cranidium GSM. 35524 (Pl. 53, fig. 10) was described by Salter (1865a : 108) as *Homalonotus edgelli*, but in the same work (pl. 10, fig. 10) he figured it as *Homalonotus bisulcatus*. Later, Reed (1918 : 272) considered the specimen to belong to the same group as *Homalonotus bisulcatus* and *H. ascriptus* Reed. In the shape of the narrow glabella and the medially thickened anterior border the specimen, a small internal mould, matches the narrow form of *Platycoryphe dentata*, but the glabellar furrows found in that species are completely absent. This may be due to the state of preservation and it seems unlikely that the specimen is specifically distinct. It is labelled merely as having been obtained from the “ ? Caradoc ” of “ Horderley ”, but the state of preservation is characteristic of the Smeathen Wood Beds which form an outcrop at and near the River Onny Valley, south-east of Horderley. These strata belong to both the *Reuscholithus reuschi* and *Salterolithus caractaci* Zones of the Harnagian Stage, but there is no indication as to which of these horizons provided the specimens.

Platycoryphe ? sp.

(Pl. 53, fig. 11 ; Pl. 55, fig. 14)

1958. *Eohomalonotus* sp. (? nov.), Dean, pp. 206, 221.

DESCRIPTION. Two isolated specimens which may belong to *Platycoryphe* have been collected from the Lower Longvillian rocks of the Onny Valley, strata much higher in the succession than any others in Shropshire known to contain the genus.

One, an incomplete cranidium (Pl. 53, fig. 11), is poorly preserved as an internal mould but can be seen to possess a glabella superficially similar to that of *Platycoryphe*

dentata, though the frontal glabellar lobe is broader and more rectangular in outline. There are three pairs of straight glabellar furrows, directed adaxially and moderately rearwards from the axial furrows and becoming progressively deeper from first to third. They resemble those of *Platycoryphe dubia* (Savage) as figured by Foerste (1919, pl. 19, fig. 15a) and, like that species, the Longvillian form has smaller basal glabellar lobes than *P. dentata* and comparable forms. The anterior border is longer (*sag.*) and transversely straighter than that of *P. dentata* but the preservation is too poor to warrant a detailed comparison.

The other specimen, a small, convex pygidium (Pl. 55, fig. 14) is also somewhat indifferently preserved as an internal mould. The frontal margin is strongly arched forwards as in *Platycoryphe dentata*, and the axial furrows also become less convergent opposite the posterior third of the axis. There appear to be seven axial rings, the rearmost two of which are less well defined than the rest. The terminal piece is poorly preserved and a comparison with that of *P. dentata* is not possible. The pleural lobes possess at least five pairs of ribs, a number comparable with that found in *P. dentata*, but the pleural furrows are straighter and directed backwards even more strongly than in that species.

HORIZONS AND LOCALITIES. Cranidium BM. In. 50511 (Pl. 53, fig. 11) is from the middle third, the zone of *Dalmanella indica* and *D. lepta*, of the Lower Longvillian Substage exposed just west of the south-western corner of Rookery Wood, three-quarters of a mile south-east of Horderley.

Pygidium BM. In. 50816 is from the lowest third, the zone of *Dalmanella horderleyensis*, of the Lower Longvillian. The specimen was collected from the western end of the quarry by the north side of the Bishops Castle road, 250 yards south-east of Glenburrell Farm, Horderley.

Genus **BRONGNIARTELLA** Reed, 1918

TYPE SPECIES. *Homalonotus bisulcatus* M'Coy, 1851 *ex* Salter MS. by original designation of Reed (1918 : 322).

The authorship of *Brongniartella bisulcata*, like that of *Kloucekia* (*Phacopidina*) *apiculata* (see p. 326) has usually been attributed to Salter though the species was, in fact, described first by M'Coy in 1851, Salter's description not being published until the following year. In M'Coy's original work (*in* Sedgwick & M'Coy, 1851, pl. 16) figs. 24–29 were said to be *Homalonotus bisulcatus*, whilst figs. 30 and 31 were varieties of the species, but according to Salter (1852) figs. 29–31 were “variety β minor”, the specimens deriving from Bala and Westmorland.

Of the specimens figured by M'Coy, the original of his pl. 16, fig. 24, was mistakenly stated, in the explanation of the plate, to have come from Pwllheli, though his text (p. 168) gave the locality correctly as “Wittingslow, near Acton Scott, Shropshire”. In the Appendix to M'Coy's work Salter stated that the originals of figs. 24, 26 and 27 came from Wittingslow (now Whittingslow, a farm three-quarters of a mile south-west of Marshbrook) and those of figs. 25 and 28 from Tremadoc (? Pwllheli). In attempting to clarify the species Reed (1918 : 270) stated erroneously that the originals of figs. 24, 26 and 27 were housed in the British Museum (Natural

History). In fact they are in the Geological Survey and Museum, though the counterpart of fig. 24 has now been traced in an old collection at the British Museum, where it is numbered In. 54914. Reed also stated, in my opinion correctly, that the species is undoubtedly established on Shropshire specimens and the original of M'Coy's fig. 24 is now chosen as lectotype. The present description is founded on the Shropshire syntypes, supplemented by further material from the type-area.

***Brongniartella bisulcata* (M'Coy)**

Pl. 54, figs. 1, 2, 4, 8, 9; Pl. 55, figs. 1, 4, 7)

- 1847. *Homalonotus bisulcatus* MS., Sedgwick, p. 149. *Nomen nudum*.
- 1851. *Homalonotus bisulcatus* (Salter in Appendix), M'Coy in Sedgwick & M'Coy, p. 168.
- 1852. *Homalonotus bisulcatus* M'Coy: Salter, p. v.
- 1854. *Homalonotus bisulcatus* M'Coy: Salter in Morris, p. 109.
- 1859. *Homalonotus bisulcatus* M'Coy: Murchison, p. 74, fig. 2.
- 1865. *Homalonotus bisulcatus* M'Coy: Salter, pl. xvi, figs. 1-8.
- 1865a. *Homalonotus bisulcatus* M'Coy: Salter, p. 105, pl. 10, figs. 3, 4, 5, 9.
- 1867. *Homalonotus bisulcatus* M'Coy: Murchison, p. 69, fig. 2.
- 1884. *Homalonotus bisulcatus* M'Coy: La Touche, p. 57, pl. 3, fig. 62.
- 1918. *Homalonotus (Brongniartella) bisulcata* M'Coy: Reed, p. 322.
- 1930. *Homalonotus bisulcatus* M'Coy: Whitcomb, p. 348.
- 1947. *Brongniartella bisulcata* (M'Coy): Harper, p. 166.
- 1948. *Brongniartella bisulcata* (M'Coy): Prantl & Přibyl, p. 15.
- 1949. *Brongniartella bisulcata* (M'Coy): Bancroft, p. 309.
- 1958. *Brongniartella bisulcata* (M'Coy): Dean, pp. 207-210, 222-223.
- 1959a. *Brongniartella bisulcata* (M'Coy): Dean, pp. 207, 220.

DESCRIPTION. The cephalon is sub-semicircular in outline, blunted frontally. The glabella is trapezoidal in plan, gently convex both longitudinally and transversely, and stands slightly above the level of the remainder of the cephalon; it is slightly longer than broad, narrowing forwards slightly so that the breadth of the frontal lobe is about three-quarters of the basal breadth. The axial furrows are shallow with poorly-defined distal margins; for about half the length of the glabella they converge gently forwards from the occipital furrow, then suddenly converge more sharply, constricting the glabellar outline, and finally continue forwards parallel to their former course but set slightly closer together. Hypostomal pits are apparently absent. There are no glabellar furrows and the glabella is generally quite smooth though an occasional specimen, for example the lectotype, shows a suspicion of a low, longitudinal, median ridge. The anterior margin of the frontal glabellar lobe is weakly convex forwards, separated by an ill-defined furrow from the anterior border: the two last coalesce to form a broad (*sag.*), smooth, frontal brim which passes laterally without division into the anterior portions of the fixigenae. The occipital furrow is shallow but well defined, transversely straight for most of its length (*tr.*) but arched forwards medially, though this feature is less conspicuous in immature cranidia. The lectotype has part of the test preserved, showing that the occipital furrow is much less well defined on the external than on the internal surface. The occipital ring is of moderate, uniform length (*sag.*), generally about one-eighth that of the glabella; in plan it resembles a flattened trapezoid owing to the fact that the axial furrows diverge rearwards markedly on meeting the occipital

furrow. The pleurooccipital furrow is set slightly to the rear of the occipital furrow ; although shallow near the axial furrows it deepens abaxially at first but then becomes shallower again, at the same time curving gently forwards, and finally dies out without reaching the lateral margins. The posterior border, where it meets the axial furrows, is of the same length (*exsag.*) as the occipital ring, but becomes longer distally and terminates in bluntly-rounded genal angles. The fixigenae are large, each with a frontal breadth about, or rather less than, half that of the frontal glabellar lobe. Between the eyes and the sides of the glabella the fixigenae are level, but to the rear of the eyes they are turned down strongly, through about 70 degrees, towards the genal angles. The eyes are small, situated opposite the mid-point of the glabella, with small, smooth, palpebral lobes which are gently declined adaxially and pass without interruption into the fixigenae, palpebral furrows being absent. From the eyes the anterior branches of the facial suture extend forwards, roughly parallel, until opposite the front of the glabella, but then become more convergent, sweeping forwards and adaxially until they meet frontally, the suture so formed being above and just inside the anterior margin. The posterior branches of the facial suture run straight backwards from the eyes for only a short distance, then arch abaxially for about half their length, and finally curve back near the lateral margins which they cut acutely at, or immediately in front of, the genal angles. Only the more robust, triangular, hindmost portions of the librigenae are usually found. Each carries a broad, smooth, level eye-platform immediately beneath the visual surface of the eye, which has not been found preserved. Below each eye-platform the librigena is convex, steeply declined abaxially, and separated from the narrow, thickened lateral border by a shallow, broad, lateral border furrow which dies out towards the genal angle and so does not meet the pleurooccipital furrow.

The hypostoma has not previously been described or figured. The overall length and breadth are about equal, and the transverse convexity is greater than that longitudinally. The median body is moderately convex, slightly elongated, divided by a broad (*sag.*), shallow, median furrow into anterior and posterior lobes, the latter about one-quarter the length (*sag.*) of the former. The anterior border is narrow (*sag.*) medially, widening distally to form large anterior wings, the anterolateral margins of which are broad and obliquely truncated. The border is delimited by a broad (*sag.*), shallow furrow which curves backwards distally, meeting the median furrow, here slightly deeper, just behind the anterior wings. The lateral margins are deeply indented by large lateral notches which produce their maximum constriction of the outline almost opposite the mid-point of the hypostoma. Behind the lateral notches the lateral margins expand distally into rounded shoulders which form flanges directed ventrally at a moderate angle. The posterior margin of the hypostoma is forked, terminating in a pair of broad points separated by a deep, curved notch. Each point carries a small indentation, poorly preserved but perhaps representing a macula. The posterior border is separated from the posterior lobe of the median body by a broad (*exsag.*), shallow furrow which runs parallel to the median furrow, finally becoming deeper and terminating level with, and a short distance inside, the shoulders.

No complete thorax is yet known from south Shropshire, but one containing ten

thoracic segments is figured here (Pl. 55, figs. 1, 4). The thoracic axis is broad, apparently more than twice the breadth of the side-lobes, though only slightly more than one-third of the total breadth in flattened specimens. Each axial ring is gently convex, its breadth (*tr.*) about eight to nine times the uniform length (*sag.*), and is separated from the articulating half-ring by a broad (*sag.*), shallow, articulating furrow. The axial furrow marking the distal end of each axial ring is oblique and runs abaxially from front to rear, its intersection with the posterior margin of the segment being marked by an articulating socket into which fits a corresponding articulating process on the subsequent segment. Outside the axial furrows the pleurae are of uniform breadth (*exsag.*), curving first slightly rearwards and then more strongly forwards to the large, bluntly-rounded tips. Each pleura carries a conspicuous pleural furrow which commences at the axial furrow as an abaxial continuation of the articulating furrow, and then arches gently back abaxially for almost half the length (*tr.*) of the pleura, when it becomes suddenly narrower (*exsag.*) and slot-like; it then curves gently forwards towards the anterior margin and ends sharply without reaching either the margin or the pleural tip.

The pygidium is parabolic in outline, broader than long in the ratio of about 4 : 3, its anterior margin arched gently forwards. It is plump, convex both transversely and longitudinally, and the upper surface is moderately declined from front to rear. The axis is subtriangular in outline, bounded by smooth, shallow axial furrows; frontally it occupies slightly less than half the maximum breadth, a proportion falling to a little less than one-third in flattened specimens. The number of axial rings ranges from nine to twelve, the most common number present being ten or eleven. The articulating furrow is deep but the remaining ring-furrows are less well defined and become fainter backwards; they are not aligned with the rib-furrows of the side-lobes and do not quite attain the axial furrows. There are generally seven or eight ribs present on each side-lobe. The rib-furrows of the first pair are deep and narrow (*exsag.*) and those of the second pair are only slightly less strongly developed, but the remainder are markedly shallower. All these furrows become much attenuated at a narrow, poorly-defined border which they cross to reach the lateral margin. The border is best developed posterolaterally and at the tip of the pygidium where, in some specimens, it is turned up slightly to form a flange-like rim, though this feature may have been exaggerated by crushing.

HORIZONS AND LOCALITIES. *Brongniartella bisulcata* is one of the most abundant and characteristic of Shropshire trilobites and may be found at numerous localities along the Ordovician outcrop. It makes its appearance in the Alternata Limestone, the basal subdivision of the Upper Longvillian Substage, and it was from this horizon that the lectotype was originally collected. The species continues through the overlying Lower Cheney Longville Flags, the upper subdivision of the Upper Longvillian Substage, but it is in the succeeding Upper Cheney Longville Flags, representing the Marshbrookian Stage, that the greatest abundance is attained. No undoubted records from later strata are known, but rare fragmentary traces from the arenaceous development of the Actonian Stage suggests that the species may eventually prove to have persisted in south Shropshire after the close of the Marshbrookian in places where the environment was favourable.

LECTOTYPE. GSM. 7626 (Pl. 54, fig. 1). The counterpart of this specimen is in the British Museum (Nat. Hist.), where it is numbered In. 54914.

FIGURED SPECIMENS. BM. In. 48952 (Pl. 54, figs. 2, 4); BM. In. 50791 (Pl. 54, fig. 8); BM. In. 49557 (Pl. 54, fig. 9); GSM. 35519 (Pl. 55, figs. 1, 4); BM. In. 48598 (Pl. 55, fig. 7).

DISCUSSION. For convenience all the species of *Brongniartella* described in this paper will be discussed together at the end of the section.

***Brongniartella caradociana* sp. nov.**

(Pl. 53, fig. 12; Pl. 54, figs. 3, 5, 7, 10; Pl. 55, fig. 2)

1918. *Homalonotus biserratus* Reed (*pars*), p. 273. MS. name only.

1958. *Brongniartella* aff. *bisulcata* (M'Coy): Dean, p. 218.

DIAGNOSIS. Large species of *Brongniartella* distinguished by conspicuously broad glabella, narrowing frontally, large, scoop-like anterior border and broad fixigenae. Paraglabellar areas developed on immature individuals.

DESCRIPTION. The cephalon has not yet been found completely preserved. The cranidium is depressed, with median length about three-fifths of the maximum breadth. The glabella is gently convex, both longitudinally and transversely, its length equal to the basal breadth. The outline of the glabella in the adult trilobite is slightly more irregular than is usual for the genus. Shallow axial furrows, containing poorly-defined hypostomal pits frontally, run almost straight forwards for about half the length of the glabella, converging only very slightly; they then become strongly convergent for a short distance, about one-seventh of the median length of the glabella, finally becoming less convergent as far as the anterolateral angles of the frontal glabellar lobe, the breadth of which is two-thirds that across the base of the glabella. In general there are no glabellar furrows present, but one specimen (Pl. 53, fig. 12) shows traces of shallow depressions which do not cut the axial furrows, but which meet mesially to form what appears as a single, broad (*sag.*), transglabellar depression or furrow. It is not clear whether this represents a pair of third glabellar furrows or whether it is the result of crushing. The frontal lobe of the glabella is slightly convex forwards, standing only slightly higher than the anterior border; the latter is broad (*sag.*) and gently inclined anteriorly so that a slightly concave, scoop-like brim results, the frontal margin of which is arched forwards mesially. The distal portions of the occipital furrow are deep and transversely straight but the median third is markedly shallower and, in the largest-known specimen, convex forwards, though straight in small individuals. The occipital ring is of almost uniform length (*exsag.*) which increases slightly mesially. In small individuals the lines of the axial furrows diverge rearwards from the frontal edge of the occipital furrow, cutting the outer ends of the occipital ring obliquely. The occipital ring of the holotype, a large and presumably mature specimen, passes abaxially into the posterior border, only faint traces of axial furrows being present. The posterior border furrow is transversely straight, moderately deep, and is set slightly to the rear of the occipital furrow. The posterior border is not yet completely known, but the

inner parts, at least, are transversely straight and of uniform breadth (*exsag.*). The genal angles have not yet been found intact. The fixigenae are large and conspicuously broad; frontally their individual breadth equals more than half that of the frontal glabellar lobe in the holotype, a proportion rising to more than two-thirds in smaller specimens. The hindmost portions of the fixigenae of immature specimens carry conspicuous, slightly-raised, subcircular, paraglabellar areas, each defined posteriorly and adaxially by the posterior border furrow and axial furrow respectively, and frontally and abaxially by a continuous, shallow, arched furrow. In smaller individuals the paraglabellar areas indent the axial furrows which then appear slightly concave abaxially, but in the largest specimen they are scarcely visible. The eyes are small, situated forwards of centre of the glabella. Small palpebral lobes are continuous with the upper surface of the fixigenae and gently declined adaxially; no palpebral furrows have been seen. The anterior branches of the facial suture arch forwards and adaxially from the eyes, meeting the anterior border in line with points mid-way between the palpebral lobes and the frontal glabellar lobe, and then converge frontally. The posterior branches curve abaxially backwards from the eyes to the as yet unknown genal angles.

The librigenae and hypostoma are unknown.

Only one specimen of the thorax has been discovered, a poorly-preserved individual (Pl. 54, fig. 3) with twelve, or possibly thirteen, segments. The thoracic axis is broad, occupying about half the total breadth. Each axial ring is of uniform length (*sag.*), bounded distally by shallow axial furrows which converge forwards markedly. Each pleura is of fairly uniform breadth (*exsag.*) and directed slightly rearwards abaxially; it carries a pronounced pleural furrow which commences at the line of the axial furrow, almost cutting the frontal margin, and then runs distally and gently backwards finally pursuing an almost median course towards the tip. It is not clear from the available material whether the furrow actually reaches the tip, nor is the shape of the latter known.

A single pygidium, small and possibly immature, which may probably be referred to the new species has been collected. Though incompletely preserved, it is broader than long, approximately in the ratio 9 : 7, and semielliptical in outline. The axis occupies more than one-third of the frontal breadth, is moderately tapered towards the bluntly-rounded tip, and occupies about nine-tenths of the overall length, excluding the articulating half-ring. Seven axial rings are visible, becoming less well defined posteriorly, but they extend for only three-quarters of the length of the axis. The pleural lobes carry five pairs of ribs, defined by pleural furrows which appear to extend to the lateral margins. The first axial ring furrow is deep and cuts the straight, moderately-deep, axial furrows in line with the equally deep first pair of pleural furrows. The remaining axial ring furrows do not quite intersect the axial furrows and are not in line with the corresponding pleural furrows. The second pleural furrows are slightly shallower than the first, and the remaining pleural furrows become progressively shallower.

The surface of the test in all the material available is covered with fine pitting visible only under the microscope.

HORIZON AND LOCALITIES. All the known specimens of *Brongniartella caradociana*

are from the limestones and calcareous sandstones forming the upper portion of the Costonian Stage, the zone of *Harknessella subquadrata*, in the district around Evenwood and Harnage Grange, near the northern end of the outcrop of the Caradoc Series in the type-area. Important localities are: the old quarry by the south-eastern side of the brook, 1,500 yards south-west of Harnage Farm; the section in Bullhill Gutter, Evenwood; various old quarries in Round Nursery, south-south-east of Harnage Grange; and Black Dick's Quarry, Evenwood.

HOLOTYPE. BM. In. 51485 (Pl. 53, fig. 12).

PARATYPES. BM. In. 50769 (Pl. 54, fig. 10); BM. In. 54871 (Pl. 54, fig. 7); BM. In. 54880 (Pl. 54, fig. 5); BM. In. 54913 (Pl. 54, fig. 3). Sedgwick Museum A. 43866 (Pl. 55, fig. 2).

***Brongniartella minor* (Salter)**

(Pl. 54, fig. 6; Pl. 55, fig. 11)

- 1851. *Homalonotus bisulcatus* (Salter in Appendix), M'Coy in Sedgwick & M'Coy, p. 168 (*pars*), pl. 16, fig. 30 (? also fig. 29).
- 1852. *Homalonotus bisulcatus* var. β *minor*, Salter, p. v.
- 1873. *Homalonotus bisulcatus* M'Coy: Salter, p. 53.
- 1891. *Homalonotus bisulcatus* M'Coy: Woods, p. 145.
- 1918. *Homalonotus bisulcatus* M'Coy var. β *minor* Salter, Reed, p. 270.
- 1947. *Brongniartella parva* Harper, p. 165, pl. 6, figs. 7, 8.

Several specimens were described and figured by M'Coy (*in* Sedgwick & M'Coy, 1851: 168, pl. 16, figs. 24-31) as *Homalonotus bisulcatus*. Of them the original of fig. 29 was unlocalized, whilst the originals of figs. 30 and 31 were stated in the text to be "supposed varieties" from "Ravenstone Dale", although in the explanation of the plate the latter locality was modified to "Ravenstone Dale, Maes Meillion". In his supplement to the foregoing work Salter (1852: v) applied the name *Homalonotus bisulcatus* var. β *minor* to the originals of figs. 29-31, both 29 and 30 being stated to derive from Bala and 31 from Westmorland. Mr. A. G. Brighton kindly informs me that the original of fig. 29 cannot now be traced in the Sedgwick Museum, and has made available the other syntypes, numbered A. 10574 (fig. 30) and A. 10576 (fig. 31).

A. 10574, which may be referred to the genus *Brongniartella*, is a pygidium said to be from the "Bala Limestone" of Maes Meillion, near Bala, Merioneth. It is associated, on the same hand-specimen, with *Kloucekia apiculata* (M'Coy), *Flexicalymene* cf. *caractaci* (Salter), *Sampo* sp. (? *oepiki* Whittington) and ? *Paucicrura sowerbii* Cave & Dean; the specimen is therefore probably of Lower Longvillian age. Owing to the state of preservation of the surface of the type pygidium it is not easy to determine the exact number of axial rings and pleural ribs present, but there appear to be eight and seven respectively. These numbers are the same as those described by Harper (1947: 166) for *Brongniartella parva*, a species which possesses a similar pygidial outline and was described from the Lower Longvillian strata of Ynys Galed, Caernarvonshire. Pygidium A. 10574 is selected here as the lectotype of *Brongniartella minor*, of which species *Brongniartella parva* Harper is now regarded as a subjective synonym.

The other syntype of *Homalonotus bisulcatus* var. β *minor* is a pygidium numbered A. 10576. The locality, given as "Ravenstone Dale", together with the state of preservation, suggests that it was obtained from the Upper Ordovician strata of the Cautley district in north-west Yorkshire, between Sedbergh, Yorkshire, and Ravenstonedale, Westmorland. *Homalonotus sedgwicki* was described from the same neighbourhood by Salter (1865a: 107) and founded by him on cranidia only; the species is in need of revision but may prove to be conspecific with the specimen figured by M'Coy. Should this be the case, the name *Homalonotus sedgwicki* would be available for both specimens.

In south Shropshire a few cranidia have been collected which agree in size and proportions with the holotype of *Brongniartella parva* Harper. All the specimens are preserved as internal moulds found in weathered lenses of sandy limestone within the Horderley Sandstone; they are apparently undistorted and show no trace of the median ridge found in *B. minor subcarinata* subsp. nov. (see later), a form which possibly also occurs, though rarely, in the Horderley Sandstone.

HORIZONS AND LOCALITIES. The earliest-known specimen is from the Lower Horderley Sandstone, Upper Soudleyan Stage, zone of *Broeggerolithus soudleyensis*, at the small, disused, road-side quarry 100 yards south-east of Glenburrell Farm, Horderley. The youngest specimen was obtained from the topmost beds of the Horderley Sandstone, the *Bancroftina typa* Zone of the Lower Longvillian Substage, at the disused quarry by the west side of New House, Horderley. Harper's type material of *Brongniartella parva* was collected from North Welsh strata containing *Dalmanella indica* Whittington together with other typical Lower Longvillian species.

FIGURED SPECIMENS. BM. In. 52315 (Pl. 54, fig. 6); BM. In. 51529 (Pl. 55, fig. 11).

Brongniartella minor subcarinata subsp. nov.

(Pl. 55, figs. 6, 8, ? 13)

1958. *Brongniartella* sp., Dean, pp. 203, 220.

1961. *Brongniartella* aff. *minor* (Salter): Dean & Dineley, p. 374, pl. 20, figs. 3, 7.

DIAGNOSIS. Subspecies of *Brongniartella minor* characterized by presence of median ridge on glabella, and constriction of glabella outline frontally. Pygidium with seven axial rings and five pleural ribs.

DESCRIPTION. Several specimens have been found, particularly in the Lower Soudleyan strata of south Shropshire, of a *Brongniartella* showing an obvious resemblance to *B. minor* (Salter) but differing consistently from that species in a few respects. There is generally a slight constriction of the glabellar outline at about its mid-point, a feature seen also in *Brongniartella bisulcata* and *B. caradociana* (see earlier); its apparent absence from the North Welsh specimens may, however, be due to their being mechanically deformed and is probably not of major significance. The obvious difference in the glabella of the Shropshire subspecies is the presence of a pronounced longitudinal ridge coincident with the sagittal line over the median half of the glabellar length. Such a structure has not been observed in *Brongniartella minor*, perhaps owing to deformation; on the other hand, Shropshire cranidia figured

in this paper as *Brongniartella minor* are apparently undistorted but show no sign of a median carina.

The pygidium of the new subspecies is of generally similar outline to that of *B. minor*, but the number of axial rings and pleural ribs is consistently smaller, being respectively seven and five, compared with eight and seven.

HORIZON AND LOCALITIES. The new subspecies has been found in moderate abundance in the higher Glenburrell Beds, representing the Lower Soudleyan Stage, zone of *Broeggerolithus broeggeri*. Localities include: the stream-section at the extreme north-eastern corner of Smeathen Wood, Horderley; the exposure behind the farmhouse, Glenburrell Farm, Horderley; and the cartway 50 yards north-east of Glenburrell Farm.

A further specimen referred tentatively to the same subspecies (Pl. 55, fig. 13) was collected from the Horderley Sandstone, Lower Longvillian Substage, zone of *Dalmanella indica* and *D. lepta*, at the old quarry by the west side of the path through Longville Plantation, 720 yards north-west of the "Earthwork" at Cheney Longville. No stratigraphically intermediate specimens have yet been found, and this suggests that the subspecies may have been subject to ecological control, showing a preference for the mudstone environment of the Glenburrell Beds rather than the, presumably, shallower conditions which gave rise to the Horderley Sandstone. The same subspecies has been collected from Habberley Brook, north-west of The Longmynd, where the higher beds of the so-called Pontesford Shales have a lithology and fauna similar to that of the Lower Soudleyan of the Onny Valley.

HOLOTYPE. BM. In. 50781 (Pl. 55, fig. 6).

PARATYPE. BM. In. 51182 (Pl. 55, fig. 8).

OTHER SPECIMEN? BM. In. 51726 (Pl. 55, fig. 13).

Brongniartella edgelli (Salter)

(Pl. 55, figs. 9, 12)

1865a. *Homalonotus edgelli* Salter, p. 108, pl. 10, fig. 11 only.

1918. *Homalonotus edgelli* Salter: Reed, p. 270.

The type and only known specimen is an incomplete, damaged pygidium, preserved as an internal mould, having an estimated projected length of 9 mm. and a frontal breadth of about 11 mm. It is strongly convex transversely and highest frontally, its dorsal surface moderately declined rearwards. The anterior margin is convex forwards medially, and terminates laterally in a pair of large facets. The lateral margins are relatively straight for the genus and converge from the antero-lateral facets at roughly 60 degrees. The tip of the pygidium is missing but the border there appears to have possessed a small lateral flange. The narrow pygidial axis occupies about one-third of the frontal breadth and tapers gently backwards, delimited laterally by deep, straight, axial furrows. The surface of the axis is damaged but, excluding the articulating half-ring, there are five axial rings in just over half the length. The side-lobes are convex, narrowing backwards and declined steeply towards the lateral margins; each has a well-developed facet and carries seven

pleural furrows, the first two of which are deep, the others becoming shallower and extending almost as far as the tip of the axis. All the pleural furrows are well defined as far as the inner margin of the doublure, but can scarcely be traced to the lateral margins owing to the poor state of preservation.

HORIZON AND LOCALITY. The specimen is a limonitic internal mould embedded in a fragment of green-brown, fine-grained sandstone. The matrix is somewhat indeterminate, but is suggestive of that found in the Lower Cheney Longville Flags. The label states merely "Acton Scott", but as this name was often used in old collections to denote the whole of the Acton Scott-Marshbrook district it is of little value. A reliable appraisal of the stratigraphical position of *Brongniartella edgelli* must therefore await the collection of further material.

HOLOTYPE. GSM. 35525.

Brongniartella sp.

(Pl. 55, fig. 5)

One specimen has been collected, an incomplete pygidium, which is apparently distinct from the other forms of *Brongniartella* in south Shropshire and may represent a new species. The pygidium, preserved as an internal mould, is almost semi-circular in outline, only moderately convex, with median length about two-thirds of the maximum breadth. The axis, occupying just over three-quarters of the median length and, frontally, rather more than one-third of the maximum breadth, tapers sharply rearwards. Laterally it is defined by straight, shallow, axial furrows, and it passes into the border with no development of a postaxial ridge. Excluding the articulating half-ring there are seven axial rings, extending almost to the tip of the axis. Each pleural lobe is moderately declined abaxially, with traces of up to seven ribs. There is evidence of small anterolateral facets and although the first two pleural furrows are deep the remainder become rapidly shallower, with the hindmost barely visible; they end abaxially at a narrow border which becomes broader (*sag.*) at and near the tip of the pygidium.

HORIZON AND LOCALITY. The pygidium was collected from a lenticular bed of weathered, sandy limestone occurring in massive sandstones of the Horderley Sandstone at the south-eastern corner of Rookery Wood, three-quarters of a mile south-east of Horderley. The horizon is in the Lower Longvillian Substage, zone of *Dalmanella indica* and *D. lepta*.

FIGURED SPECIMEN. BM. In. 51520.

DISCUSSION. *Brongniartella caradociana* is of particular interest as it is the earliest species of the genus known from south Shropshire, appearing suddenly in the top-most Costonian strata within a geographically restricted area of the county. The holotype is also the largest form of *Brongniartella* yet known in the Caradoc District prior to *B. bisulcata*, which does not appear until much later, at the base of the Upper Longvillian Substage. All the stratigraphically intervening species are of small size. Our incomplete knowledge of the pygidium *B. caradociana* makes comparison with other species difficult, but the cephalon is easily distinguished from that of *B. bisulcata* by the broad glabella and large size of the fixigenae. Small individuals provision-

ally assigned to *B. caradociana* possess distinctive paraglabellar areas which have not yet been seen in any of the other Shropshire material of *Brongniartella*. The name *Homalonotus rudis* has sometimes been applied to specimens of *Brongniartella* now known to belong to *B. caradociana*. *H. rudis* was first described and figured by M'Coy (*in* Sedgwick & M'Coy, 1851 : 168, pl. 1E, figs. 20, 20a) from the Capel Garmon district, Denbighshire, and the syntypes are in the Sedgwick Museum, where they are numbered A. 10564 and A. 10565. Both are incomplete, distorted pygidia from which it is virtually impossible to obtain an accurate impression of the species, and it is suggested that the specific name should no longer be used until well-preserved topotype material has been adequately figured and described.

The eastern North American species *Brongniartella trentonensis* (Simpson) has been shown by Whitcomb (1930) to be remarkably similar to *B. bisulcata*, but the glabella of the former is narrower and conspicuously more carinate than that of the latter, whilst the pygidium of *B. trentonensis*, although possessing a comparable number of axial rings and pleural ribs, is proportionately broader and has an axis which is more strongly convergent posteriorly.

The characteristic species of the genus during the Lower Longvillian is *B. minor*, a form which may have developed from the closely similar *B. minor subcarinata*. The latter may be separated on the basis of the carinate glabella and the smaller number of axial rings and pleural ribs, and its presence in the Lower Longvillian is somewhat doubtful; it is certainly more characteristic of the Lower Soudleyan and has not yet been found coexisting with *B. minor*.

The relationship between the generally small species of *Brongniartella* existing in south Shropshire during the deposition of the Soudleyan and Lower Longvillian rocks, and the large *B. bisulcata* of the Upper Longvillian is still not clear. Certain other shelly fossils, for example *Kloucekia* and *Bancroftina*, exhibit a trend towards a larger size of individual above the boundary separating Lower and Upper Longvillian in south Shropshire, perhaps as the result of a change in environment, but such an explanation seems inadequate to explain the appearance of *B. bisulcata*, and it is more likely that the latter is an immigrant form, perhaps from elsewhere in the Anglo-Welsh area.

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